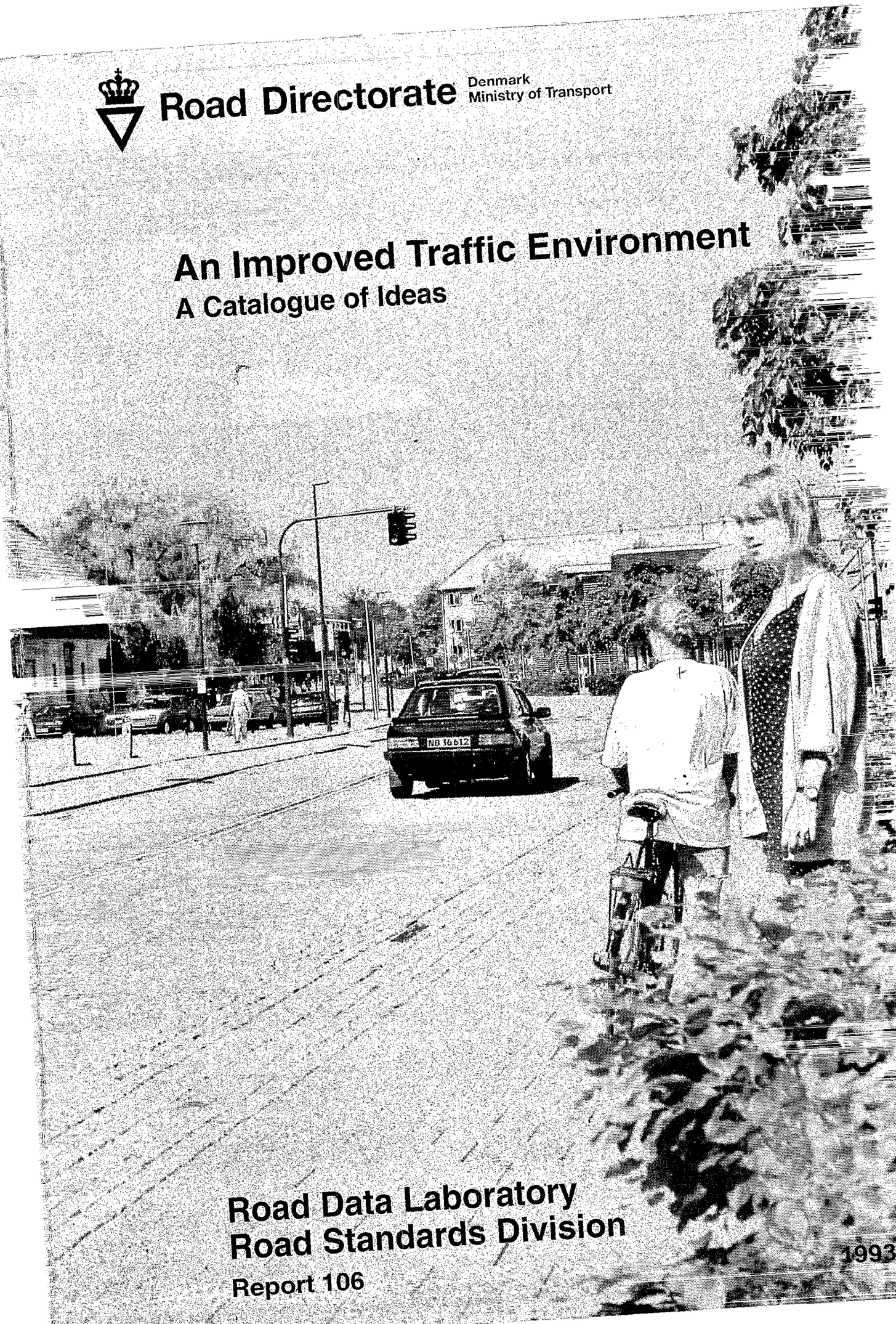
Road Directorate
Denmark
Ministry of Transport

An Improved Traffic Environment

A Catalogue of Ideas



Road Data Laboratory
Road Standards Division

Report 106

1993

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Abstract:

Traffic Calming has been used and developed during more than 20 year in Denmark, Franceand Germany. A great experience has been gained and summarized by the Danish Road Directorate in this Catalogue.

A number of the initiatives which have been taken in recent years in order to reduce the negative impact of car traffic in urban areas can be summarized in the concept of traffic calming. In this catalogue of ideas the definition of the concept is: conversion with the aim to reduce the volume of car traffic and/or reduce car speed on a particular spot, in one or several streets or in a whole precinct.

The catalogue contains a brief description on the development of the traffic calming concept, the planning process, a short account of what can be achieved by reducing car traffic volume and lowering car speed, introduction of the concept of traffic management by design, the elements of urban space and speed levels - streets and roads, squares, points - from both large and small towns, cheap and expensive solutions and both wholly and partly implemented schemes. Each example includes a description in text and pictures of the conversion and the results achieved.

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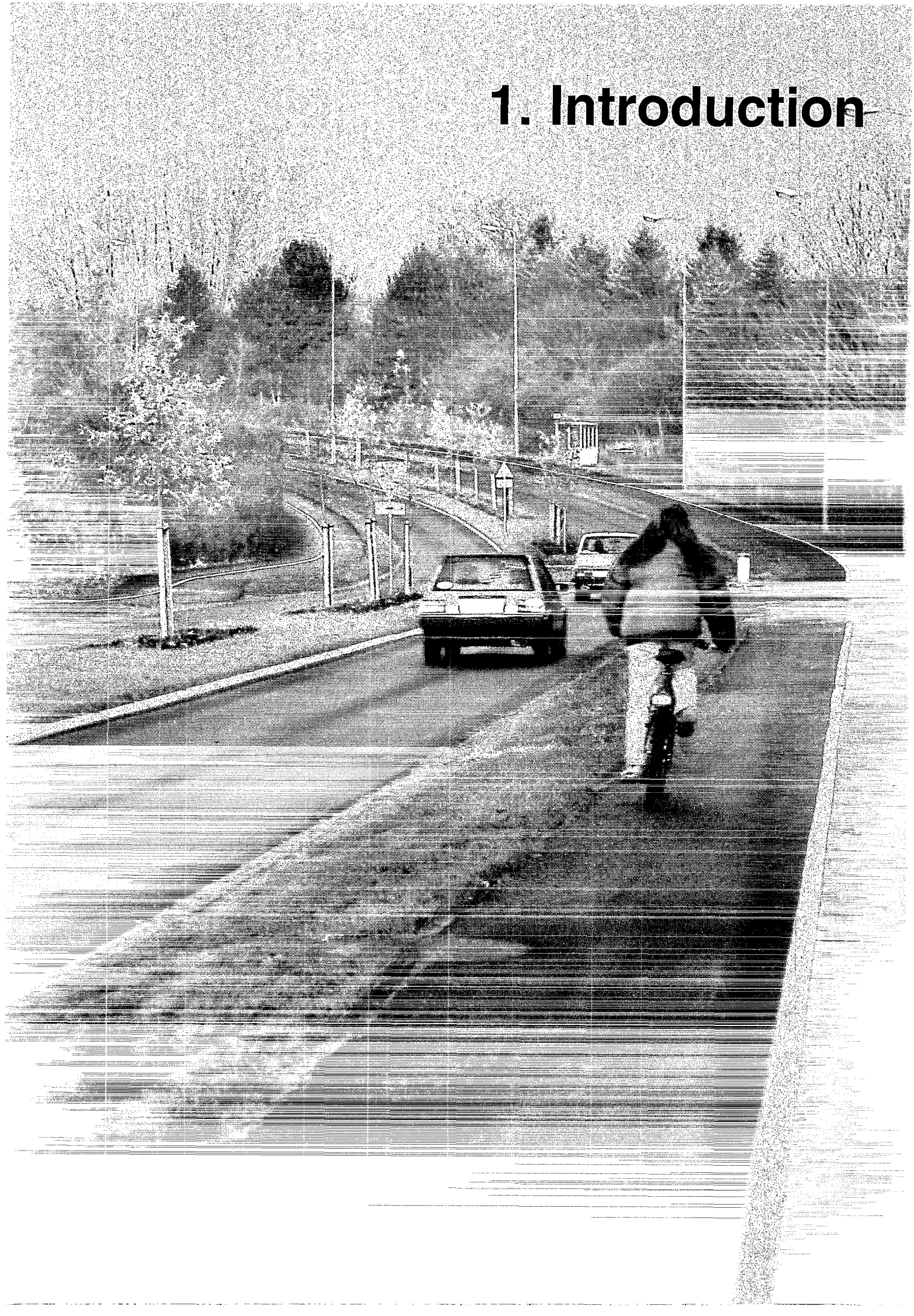
1. Introduction



Towns and Traffic

Traffic is an inevitable - and indispensable - part of urban life.

The fact that people live in towns is in itself an expression of their own and society's need for communication. The larger the towns, the more traffic will be generated by this need. And given the form that urban areas have developed and given most people's wish to move freely between starting point and destination, a substantial part of the traffic will be by car.

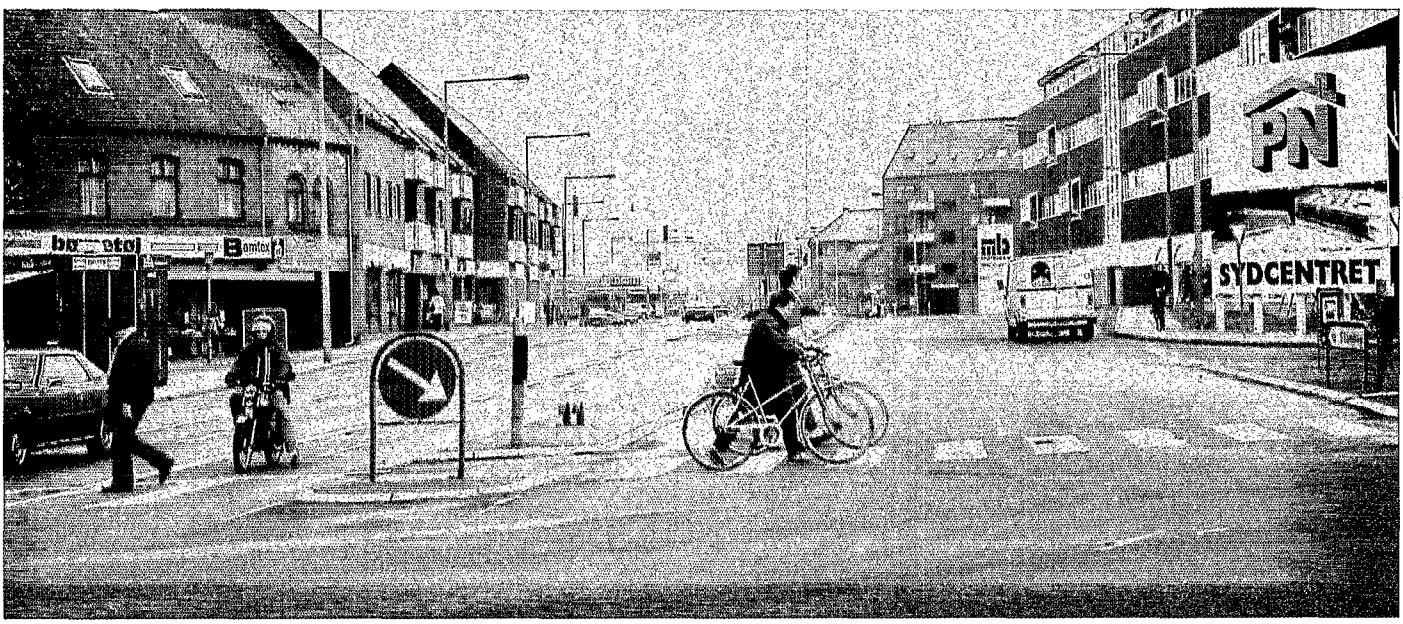
It should therefore be an accepted premise by all those involved in the planning and design of our urban traffic systems that the cars are here to stay - for many years, at least - and that a general increase in car traffic should actually be expected in the years to come.

However, it should also be recognized that car traffic constitutes a growing threat to the quality of urban life. The large majority of traffic accidents happen in towns, and cars are major contributors to noise and air pollution.

This is not a new realization. But in recent years it has been given a distinctive voice, both internationally and nationally.

The 1987 report of the Brundtland Commission *(1)* describes how the world's and especially the industrialized countries' attitude to energy consumption and pollution must be changed radically if the globe is to envisage an acceptable future - a subject of so far-reaching consequences that car traffic is only a tiny, although significant, part of the overall picture.

The town was adapted to the road.



The EC "Greenbook on the Urban Environment" from 1990 *(2)*, which assumed that the car should be a possibility rather than a necessity, contains a range of general recommendations about the control of urban traffic with a view to improving the urban environment.

Against the background of the ideas propounded by the Brundtland report concerning a sustainable development, the Danish Government's Transport Action Plan of 1990 *(3)* formulates the objective of promoting an efficient traffic system where the harmful effects of traffic, such as the environmental impact and accidents, can be minimized.

The Danish Road Safety Commission's Action Plan from 1988 *(4)* states as its main objective that the number of people killed or injured in traffic should be reduced by 45 per cent before year 2000. The plan emphasizes among other things the initiatives which can be taken locally: the introduction of differentiated speed limits in urban areas, traffic reorganization and speed reduction, improvements of intersections, etc.

All of the above-mentioned global propositions should be followed up on a local scale. First and foremost it should be recognized that we cannot just let things drift in the hope that the problems dissolve themselves. Secondly, that towns neither can nor should be moulded to the requirements of car traffic. On the contrary, it is essential to reduce car traffic, especially in sensitive areas, and to adjust residual car traffic to the towns and their inhabitants.

As it appears from e.g. this catalogue of ideas, such views have already gained a foothold in many places both in Denmark and abroad.

Traffic Calming

A number of the initiatives which have been taken in recent years in order to reduce the negative impact of car traffic can be summarized in the concept of traffic calming. The corresponding Danish word (trafiksanering) implies that traffic conditions are made sounder - and over time the word has been used as a label for many different measures taken to achieve this end.

In this catalogue of ideas the definition of the concept is used which has become generally accepted: conversion with the aim to reduce the volume of car traffic and/or reduce car speeds - on a particular spot, in one or several streets, or in a whole precinct.

To the extent possible, descriptions of conversions have been included in which traffic calming is part of a larger plan aiming at a general improvement of the urban environment.

Objective of the Catalogue of Ideas

The main objective of this catalogue of ideas is to provide inspiration for local initiatives in towns and municipalities.

The catalogue addresses itself to politicians to give them an impression of what has been done in various locations to overcome problems that are similar to those facing politicians today - and not least to demonstrate what has been achieved in particular places.

It also addresses itself to technicians, providing inspiration for concrete designs etc. - although detailed technical specifications must be sought elsewhere, especially in the Road Standards.

Last but not least the catalogue may be used by residents' associations, interest groups etc. - in short, by all who take an interest in their town and its future.

The road was adapted to the town.

Contents of the Catalogue of Ideas

The catalogue is divided into a general section (chapters 1-8) and a list of examples (chapter 9).

Chapter 2 contains a brief retrospective on the traffic calming measures of the previous 30 years. Development is described with an emphasis on experience and lessons that have been learnt with a view to future initiatives.

The subject of chapter 3 is the planning process. The legal framework is mentioned, but not summarized, and a brief account is provided of the data collection, the planning, and the necessary follow-up - against the background of the far more detailed description in the Road Standards.

In such a catalogue of ideas great importance is attached not only to the description of various types of traffic calming, but also to pointing out the consequences to be expected from individual initiatives. Chapter 4 therefore contains a short account of what can be achieved by reducing car traffic volume and lowering speeds - in terms of traffic safety, the feeling of security, measurable effects regarding environmental impact, and people's response to individual initiatives.

Chapter 5 is about urban architecture. The relationship between various kinds of traffic and the perception of urban space is described and the point of view is advocated that traffic calming plans should pay attention not only to calm the traffic but also to the visual environment, and the concept of traffic management by design is introduced.

In chapter 6 the elements of urban space are described in detail, including the use of plantings, lighting, furniture and equipment, etc.

Likewise, chapter 7 is a detailed account of various techniques of speed reduction such as humps, staggerings, narrowings, etc. - and the consequences of the individual techniques are listed.

Chapter 8 suggests how the individual techniques of speed reduction and the elements of urban architecture can and should be co-ordinated into well-functioning wholes.

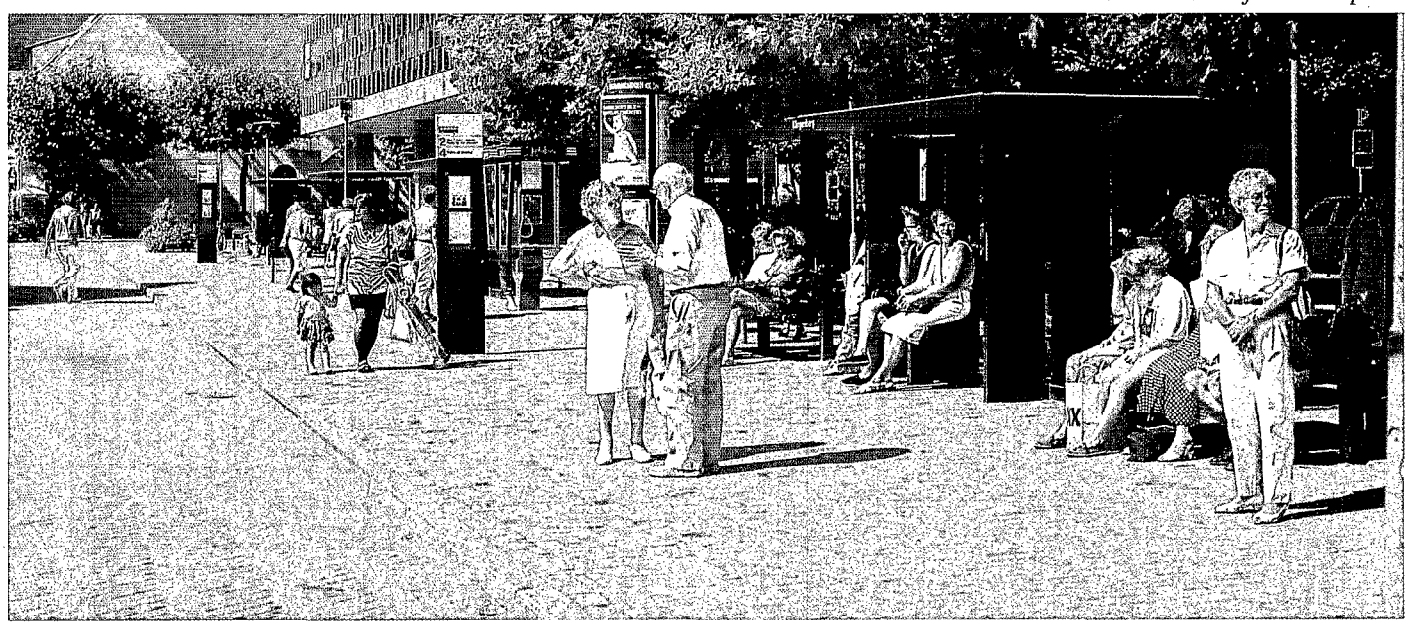
The list of examples in chapter 9 is the main chapter of the catalogue. It contains Danish and foreign examples of traffic calming at various levels (streets and roads, squares, points) - examples from both large and small towns, cheap and expensive solutions alike, and both wholly and partly implemented schemes.

Common to these examples is that in their entirety or in their details they have all been so successful that they may serve as an inspiration to others.

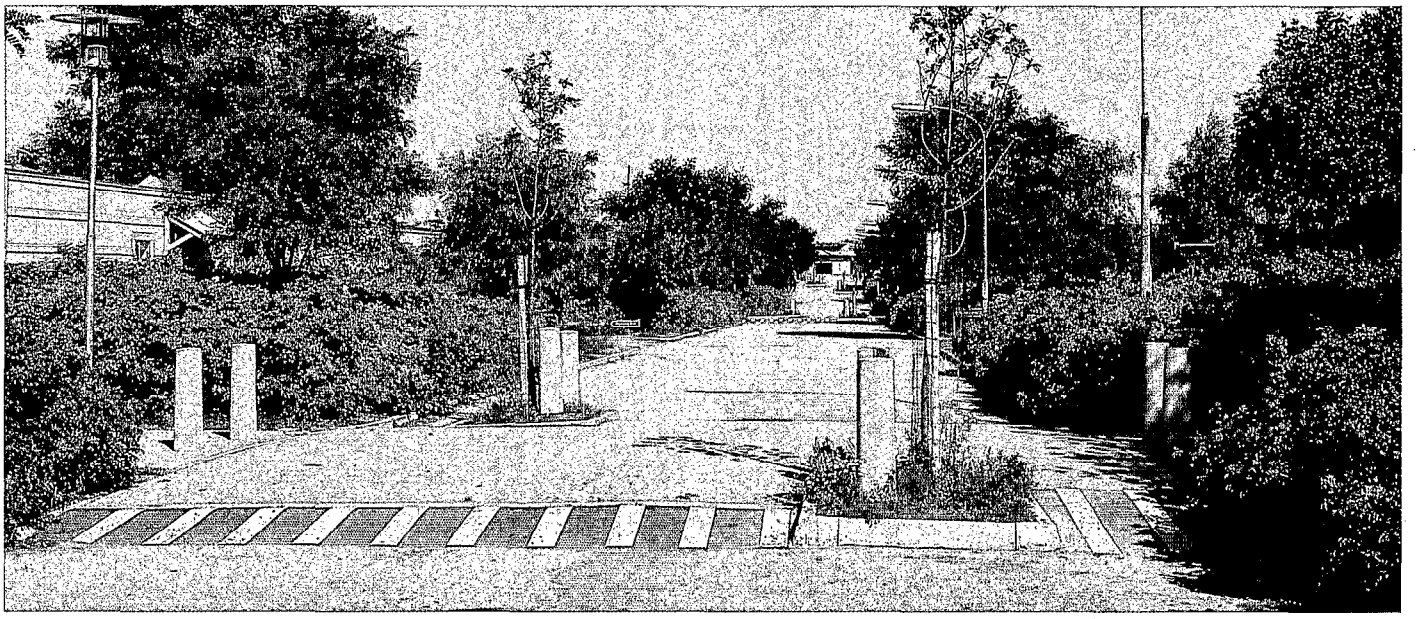
Each example includes a description in text and pictures of the conversion and, where possible, a survey in standardized format of the results achieved.

Finally, the bibliography contains a list of the accessible literature used. Bracketed numbers in the text of the catalogue of ideas refer to the numbers of the bibliography.

Odense town centre - one of the examples.



Traffic calming Development experiences



30 Years of Development

Traffic Differentiation

The concept of traffic calming emerged in the 1960s. At that time all good urban traffic planning was based on the principle of traffic differentiation. Heavy and light road users should be separated, fast road users from slow, and intensive car traffic should be removed from residential areas and other urban functions *(5)*.

The principle was developed with regard to the many new urban areas which were developed in this period, and it was an expression of the wish both to secure the free passage of cars and to provide for safe and environmentally acceptable residential areas.

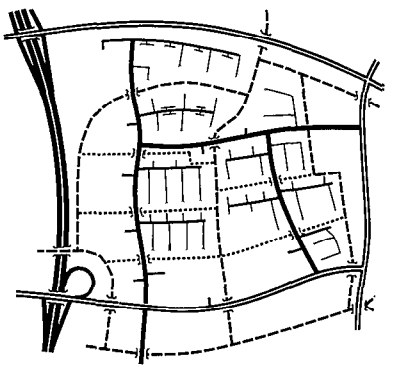
The road network was classified into primary roads, district distributors, local distributors, and residential roads. A separate path system was created so that only the blind local distributor roads and residential roads were shared by pedestrians and (few) cars. Where paths crossed primary roads or district distributors this would take place at different levels.

According to this traffic principle a large number of safe and peaceful areas were created in the period 1960-75, with path systems which over time have become beautiful and safe connections to schools, children's institutions, etc.

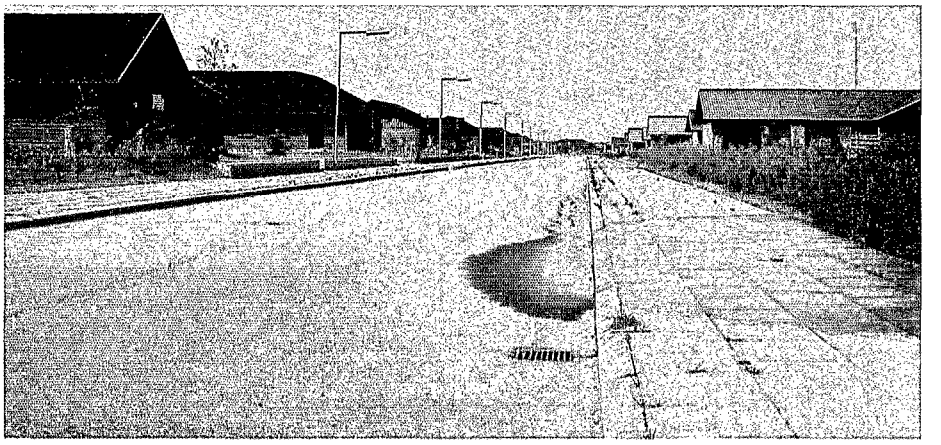
However, a range of problems could not be solved using the traffic differentiation principle:

It proved to be impossible to co-ordinate land use planning and traffic planning with such consistency that it became natural for pedestrians and cyclists to use the main paths *(63)*. The result was that they also used the primary roads and district distributors where, in keeping with the design principles, there were no sidewalks or cycle tracks.

Local distributor roads and residential roads often became too long, which tempted the few car drivers there into speeding.



Differentiated road and path networks.



The long local distributor roads tempted to speeding.

The paths provided safety and security in relation to the car traffic but on the other hand they also caused some apprehension of criminal assaults.

And finally, precisely this period was the heyday of industrialized house building, producing massive residential estates, and the principle of traffic differentiation was given some of the blame for the often bleak housing environments.

Planners tried to base traffic calming on the principle of traffic differentiation. Some (very expensive) flyover intersections of main path routes and existing primary roads were established and many residential roads were made blind by road closures.

However, it proved absolutely impossible to separate heavy and light road users. Road closures sometimes caused such long detours that the aggregate inconvenience was increased, and local roads were still the scene of excessive speeding.

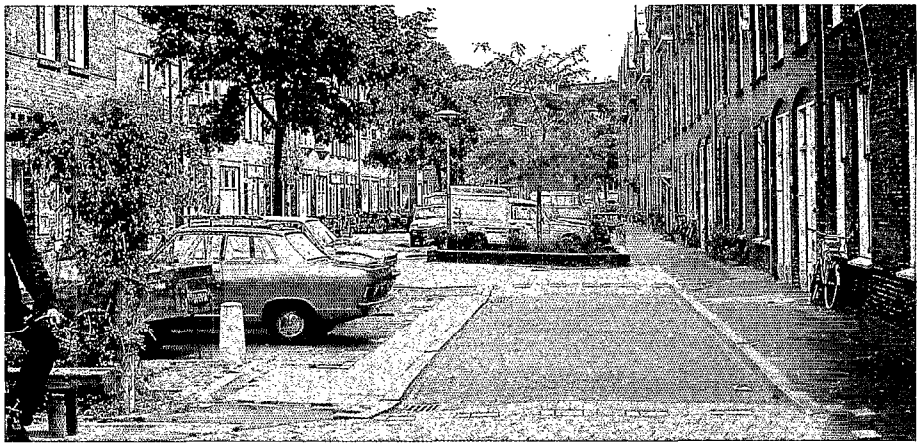
The Woonerf Idea

The solution to some of the problems came in the beginning of the 1970s from Holland, where the so-called "woonerven" were established *(6, 64)*:

In individual residential areas, i.e. areas delimited by the primary roads and district distributors, the local roads were made more tranquil primarily by making car drivers reduce speed considerably.

This was achieved by narrowing the carriageway area, by staggerings, humps, and by using paving stones in different colours in accordance with the Dutch tradition of using hard burned paving bricks for road surfaces.

By way of experiment whole roadway areas were designed as shared areas equipped with tables, benches, sand boxes etc. - but in such a way that cars could still pass, provided that they drove at a very low speed, i.e. on the terms of the pedestrians and the playing children.



From a woonerf in Delft.

In certain places these experiments resulted in marked improvements of the visual environment by a well-balanced use of furniture, plantings, and materials, and through the organization of parking.

The woonerf idea did not solve all problems either. It was limited to local areas, and conflicts could appear, especially where light road users had to cross heavily trafficked roads on the borders of the local areas.

Nonetheless the idea gave the concept of traffic calming a great push forward. It spread rapidly all over Northern Europe and had a special impact in Denmark *(65)*.

Shared Areas

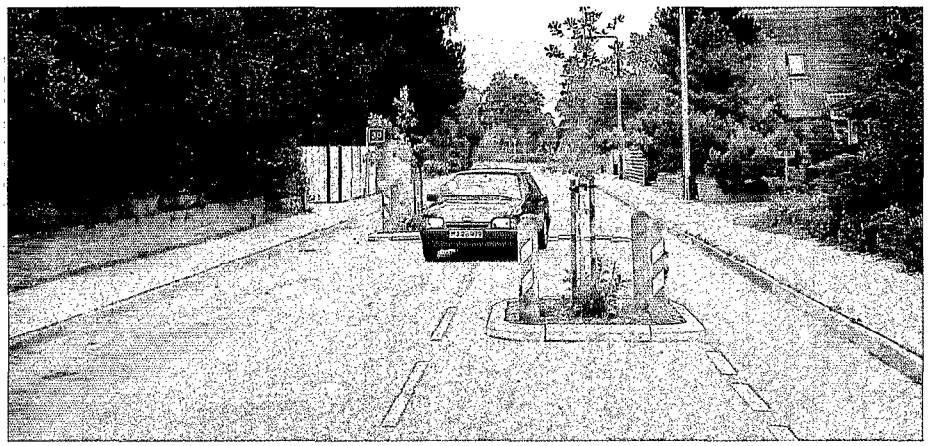
In 1976 this led to the passing of §40 of the Danish Road Traffic Act, which provided the possibility of establishing roads, primarily in residential areas, where public space and play were to be the primary functions. The right of way in these "shared areas" was changed so that pedestrians had the right of way over drivers, and the recommended speed was set at 15 km/h *(7)*.

As in Holland the speed reduction was supported by physical measures and care was taken that the design emphasized the main functions of public space and play, for example by avoiding the establishment of proper carriageways and sidewalks on different levels.

Silent Roads

Provisions were also made to allow various speed reducers on local roads where reduced speed was wanted without changing the right of way. The

One of the first Danish shared areas.



Silent road.

recommended speed chosen for these "silent roads" was 30 km/h.

The concept of silent roads became particularly successful. Within only a few years several hundred kilometres of silent roads had been established and subsequent studies demonstrate also that the effects constitute a success, as the number of accidents on these roads has fallen dramatically since their redesign *(8)*.

Traffic Roads

Until 1980 traffic calming efforts were concentrated on the local roads, especially in residential areas with low-rise development. Naturally, on the traffic roads much reconstruction work had been carried out to remove black spots and to make other improvements of traffic safety, but no traffic calming had taken place in the general sense of the word.

It is, however, on the traffic roads that the increasing traffic and the declining respect for speed limits cause the most serious safety and environmental problems. In 1981, therefore, the Danish Road Directorate prepared the report "Highways through Towns - a Catalogue of Ideas" *(9)*.

The catalogue contained new ideas as to how car speeds could be reduced using staggerings and narrowings of the carriageway, how pedestrians' opportunities to cross roads could be improved by the introduction of traffic islands and roadside reservations etc., and how conditions could be eased for cyclists by establishing bicycle tracks - all combined with a reorganization of car parking, plantings, etc.

In the mid-1980s these ideas were implemented in the 3 experimental towns of Vinderup, Skærbæk, and Ugerløse, on arterial highways with an annual traffic per day of 3-4,000 vehicles *(10)*. The effects of the experimental projects were studied in the very comprehensive, socalled "EMIL-project" (Consequence evaluation of environmentally adapted through roads) *(11, 12, 13, 14)*.

The large majority of the experience gained was positive. Speeds decreased, traffic safety was improved, and the environmental impact was reduced. And equally important were the road users' and the inhabitants' very positive evaluations of the changes.

The good experience with the experiments resulted in a series of similar projects, also on roads with more traffic than in the three towns , i.e. with an annual traffic per day of up to 20,000 vehicles.

Planning

Simultaneously with the last 15 years' development of the principles and methods of traffic calming a solid foundation has been created for the planning which ought to be a logical precondition for any traffic calming scheme.

Already the Danish Municipal Plan Act with its requirements to the main structure of the Municipal Plan and its distinction between traffic roads and local roads constituted a good starting point. But especially the new Road Standards for urban areas, the "Urban Traffic Areas" from 1991 contain concrete guidelines with a direct focus on practical traffic planning, based on the principle of a speed differentiated road network *(15)*.

Geometrical Design

Another positive aspect of the Road Standards in this connection is that they describe the detail design of speed reducers for different speeds *(16)*. Thus total correspondence can be ensured between the planning of speed differentiated road networks, their subsequent design, and also the road users' consequent behaviour.

Environmentally adapted through road.

Further Initiatives

Until today the main objective of traffic calming has been to further traffic safety and security. Most experiences have been of a positive nature, but lessons have been learnt from mistakes as well.

The traffic calmings of the years to come will be based on the experience gained. But in addition such reorganization must aim to fulfil the global objectives referred to in chapter 1.

Against this background a series of general requirements can be defined regarding the traffic calming initiatives - here summarized very briefly:

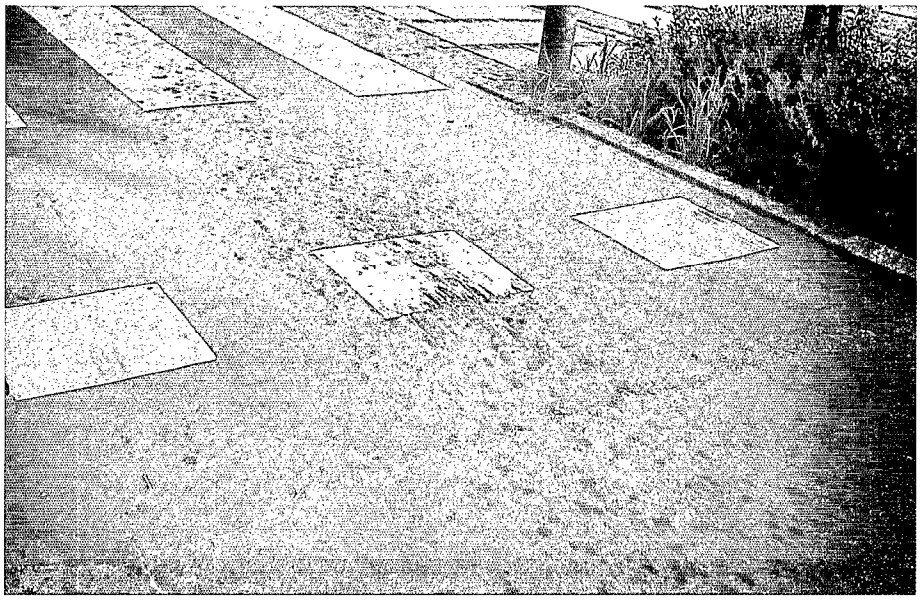
Traffic calming should be made part of a complete "sustainable planning" for our towns and cities with regard to both traffic safety, the environment, and energy efficiency.

Of course, this should not preclude the implementation of local traffic calming schemes with the specific aim of improving traffic safety.

In any circumstances and no matter whether it involves one road or a town precinct, any traffic calming should have as a platform a traffic reorganization plan for the whole area or the entire town. The traffic reorganization plan should identify the main routes of individual road user groups, including points of conflict between heavy and light road users plus a speed classification of the road network.

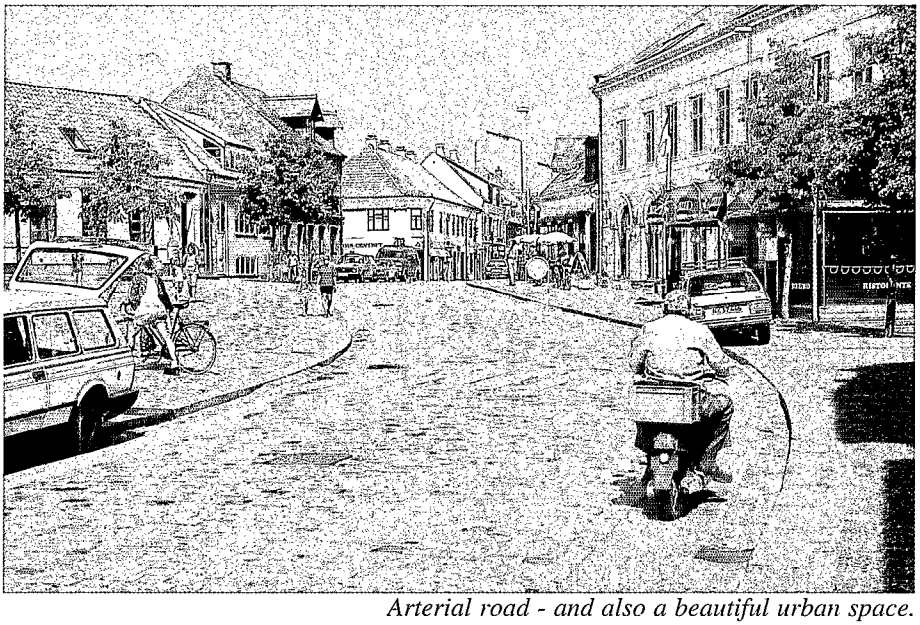
With a view to the conservation and enhancement of valuable urban milieus careful attention should be paid to the architecture of the town as well as of buildings.

Additionally, the growing awareness of the importance of the visual environment should ensure that great care be taken not only regarding the technical aspects of the traffic calming, but also in the total design of the urban spaces.



Hump from before the Road Standards.

Hump in accordance with the Road Standards.



Arterial road - and also a beautiful urban space.

Such considerations can be expensive. Where within a necessary resource constraint cheaper solutions are specified, they should be planned as improvements by stages which are as attractive as possible, and which point towards beautiful and integral final solutions.

Experience shows that it can be particularly difficult to create satisfactory conditions for cyclists. Special attention should therefore be devoted to bicycle traffic.

The same applies to various groups of handicapped people.

Residents, interest groups, and others should be involved in the planning process at an early stage.

It is essential that the individual traffic calming measures are designed in strict compliance with the first intentions, especially with the initial speed classification in mind.

3. Planning

Laws, Standards, and Guidelines

The Planning Acts

The Danish Municipal Planning Act of 1982 *(17)* distinguished between 3 main kinds of traffic, i.e. motor car traffic, light road users, and public transport. The Act stipulated that when the municipal main traffic structure is planned, the following should be defined:

- the main road network
- the main traffic network for light road users
- the public transport network

and therefore, among other things, which roads are to be traffic roads and which local roads.

In the local-plan framework of the municipal plan the principles of the detail design of the road network should be specified. It could be decided, for example, which quarters or individual roads should be provided with speed reducers.

However, the specific design of the individual traffic elements should await the preparation of the individual local plans.

The Planning Act of 1991 *(18)* is less specific on these points, but the principles of the Municipal Planning Act can still be used with some advantage in municipal planning.

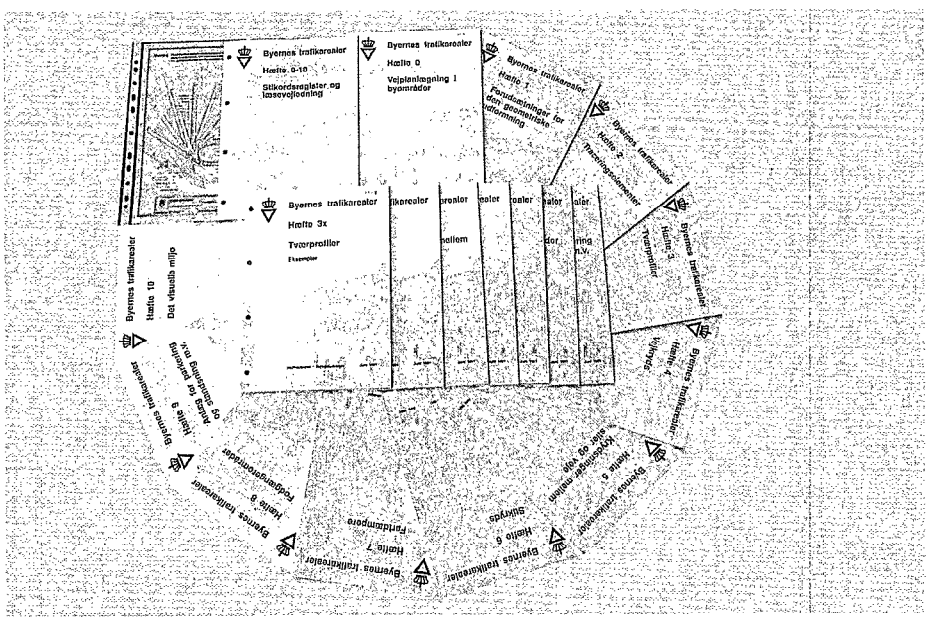
Traffic and Municipal Planning

"Traffic and Municipal Planning, Municipal Plan Information No. 10, National Agency for Physical Planning 1984" *(19)* contained a broad description of the traffic problems which have to be treated and solved if possible, a description of national policy objectives and a tentative municipal traffic policy.

In addition the document contained a number of general requirements for the traffic road network, the main path network, the public transport network, and the traffic-related subjects of the local-plan framework.

The Environment and Traffic in Municipal Planning

"The Environment and Traffic in Municipal Planning, 1992" *(20)*, guidelines issued by the National Agency for Physical Planning, is a follow-up to the Government's Transport Action Plan



Road Standards for Urban Traffic Areas - a necessary platform.

and the Road Traffic Safety Commission's Action Plan.

The guidelines speak of traffic planning, including traffic calming, as part of a global planning approach that pays attention to traffic safety, energy efficiency, and all the environmental consequences of traffic.

Urban Traffic Areas

The Road Standards "Urban Traffic Areas, Danish Road Directorate, Road Standards Committee, 1991" provide, against the background of the Municipal Planning Act and the guidelines issued by the National Agency for Physical Planning, more detailed instructions on the planning and design of the road network.

In the total series of 11 volumes of Road Standards, volume 0 "Road Planning in Urban Areas" *(15)* is concerned with road planning with particular reference to traffic calming and speed reduction.

Among other things the volume describes a road classification principle operating with traffic roads and local roads and subsequent speed classification.

Odense Municipality's goals for reducing the number of accidents.

Proposals are made for an action plan for traffic safety in Odense municipality aiming to reduce the number of traffic casualties by at least 30% in 12 years.

Four other volumes are of particular interest in this connection:

- volume 1, "Premises for the Geometrical Design" *(21)*, contains a brief account of the data collection that should precede any planning and design of, for example, roads with speed reducers.
- volume 7, "Speed Reducers" *(16)*, presents the correct design of speed reducers depending on the desired speeds.
- volume 8, "Pedestrian Zones" *(22)*, as the title indicates, concerns an important group of the traffic calmed streets.
- volume 10, "The Visual Environment" *(23)*, illuminates an essential but previously neglected aspect of road design in urban areas.

Other Literature

Further guidance and inspiration can be sought in a very long list of publications. Some of the most important of these appear in the bibliography at the end of this catalogue of ideas.

Objective

As a general background for traffic calming the national and international objectives referred to in chapter 1 should be supplemented by municipal traffic policy objectives *(24)*.

Such objectives may be of a general nature and concern subjects such as

- safety and security
- environmental protection
- passability and accessibility
- weighing of individual considerations

or they may be specific and concern subjects such as

- maximum limits for noise and air pollution
- reduction of the number of accidents

The formulation of the goals might very appropriately take place in the public debate associated with the revision of the municipal plan.

Planning Considerations

As regards procedural details in the planning of traffic calmed areas or speed reduction on individual roads reference is made to the guidelines mentioned above.

However, it would be appropriate, in a catalogue of ideas, to point to a number of considerations that must not be neglected in the planning process:

Relation to the Municipal Plan

In practice the traffic calming is carried out successively during the municipal plan period. To ensure consistency in the municipal planning, the traffic calming should first of all be based on the municipal plan in force, and secondly it should be regarded as an initial study for the next revision of the municipal plan.

Relation to Other Sectors

Depending on the size and organizational structure of the municipality, the individual sector plans will often be prepared more or less in isolation from each other.

It is generally advisable to co-ordinate the individual sector plans as well as possible, i.e. in addition to the co-ordination that takes place in connection with the revision of the municipal plan. This is particularly important for traffic calming, especially the interfaces with

- urban renewal plans
- green plans
- plans for utility pipe maintenance
- plans for road surface replacement

Joint cross-sector planning will primarily ensure the necessary co-ordination of timing and design. Simultaneously, it will improve the interdisciplinary understanding of the problems

The result of co-ordinated traffic calming and green planning.

and may thus result in better, more integrated solutions. Additionally, such a collaboration provides good economic allocation opportunities, to reap as much benefit as possible from the financial resources available.

The Public

Experience shows that traffic schemes are among the subjects that the public are most interested in. The general requirement of public participation in the planning process is therefore particularly valid in the field of traffic calming.

Another argument for this is the general experience that people's satisfaction with completed projects depends very much on their own feeling of having been consulted.

Geographically, the involvement of the citizens should cover the area which will be affected by the changes considered. If the town centre, or areas of particular historic, cultural, or recreative interest are at issue, everybody should be involved.

Depending on the nature and scope of the subject, public participation may take the form of a combination of public meetings, door-to-door canvassing and published discussion papers, and committee work with representatives of different points of view.

In the latter case one should carefully survey who might have an interest in the planned changes of the traffic. Interested parties might be

- houseowners' associations
- tenants' associations
- local chambers of commerce
- Road Safety Council
- school boards
- groups of handicapped people
- environmental action groups
- cyclists' associations
- etc.

Classification

In traffic calming and other planning contexts the simple, functional classification into traffic roads and local roads has proved to be very expedient.

It is also important that a speed differentiated road network is planned, i.e. that any road or stretch of road is assigned a desired speed depending on the road characteristics, the sensitivity of the surroundings, the number of light road users, etc.

Detail Planning and Design

Naturally, it is equally important that the detail planning and design of the roads live up to this speed classification; that provisions are made, perhaps by road closures and/or other traffic-related measures, to ensure that local roads are only used as local roads; and that correct siting and design of speed reducers ensure that cars do not exceed the stipulated desired speed.

Initial Studies, Follow-up, and Evaluation

Initial Studies

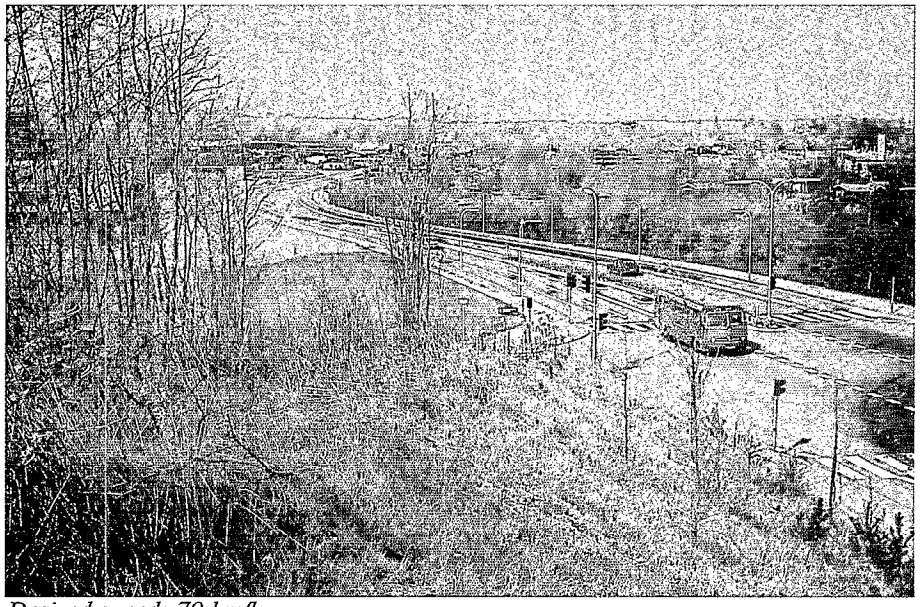
Data collection and other initial studies should be limited to what is necessary and adequate. Under any circumstances, prior to a traffic calming scheme, information should be gathered for the relevant area regarding

- function and characteristics of the area
- traffic flow for all road user groups
- car speeds
- accidents

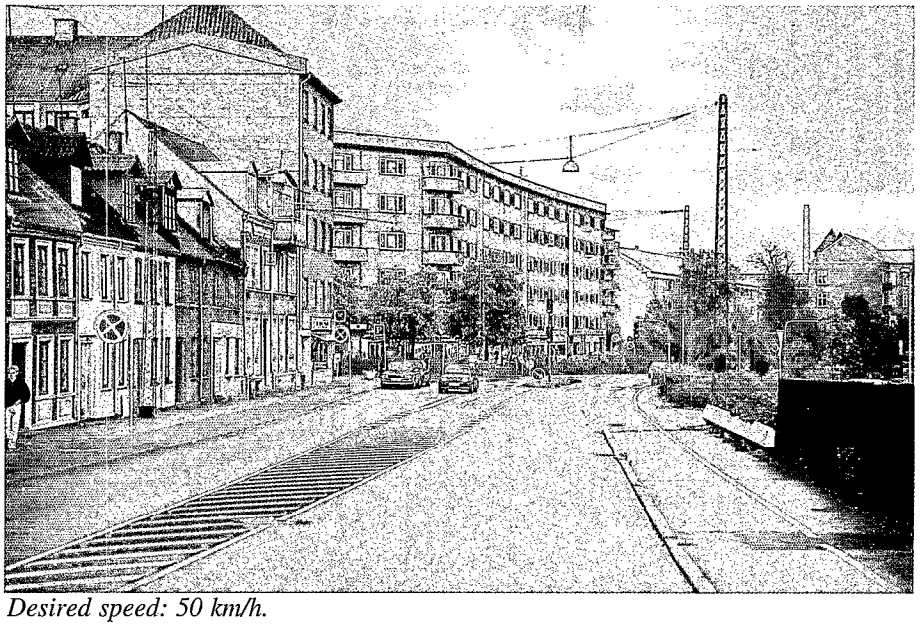
and, to the extent necessary, also data on

- noise
- air pollution

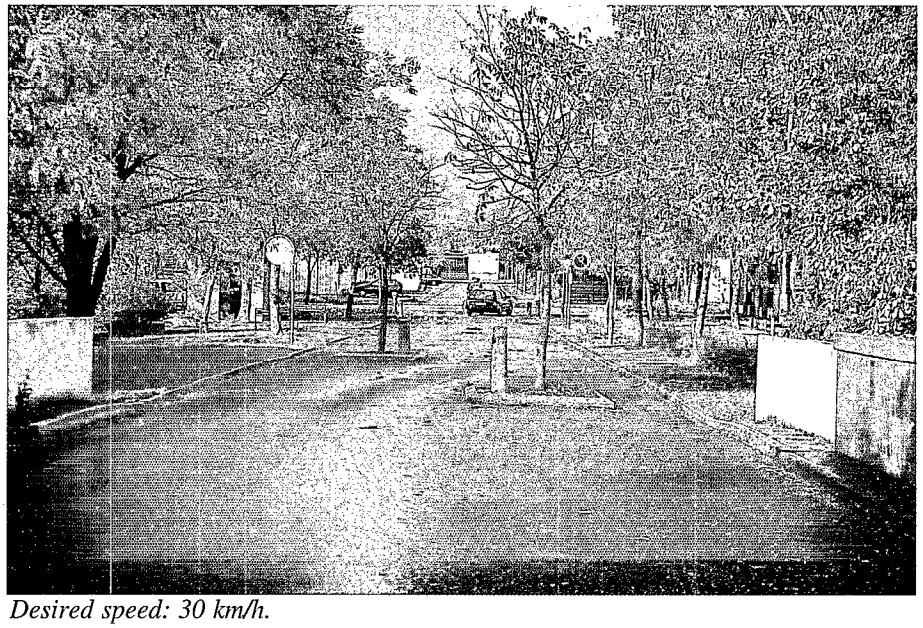
A short account of the required data collection is presented in "Urban Traffic Areas", volume 1 *(21)*.



Desired speed: 70 km/h.



Desired speed: 50 km/h.



Desired speed: 30 km/h.

Follow-up

Especially for major redesigns of traffic that involve substantial changes of the road users' flow patterns it may be necessary to inform the public about the changes.

This information can be communicated in various ways, e.g.

- door-to-door information leaflets
- info-spots on local radio
- statements in the daily press and local papers in the form of adverts or editorial articles
- informative material dispatched to schools, children's institutions, rest homes, etc.
- posters and streamers
- etc.

A more detailed account of the possibilities is found in "Local Campaigns for Safe Traffic, Danish Road Directorate 1987" *(25)*.

After-Studies

There are two main reasons for conducting after-studies:

First, for the sake of the project in question, it should be ascertained whether the changes fulfilled the intentions, so that mistakes, if any, can be rectified.

Second, for the sake of future schemes, such studies enhance the municipality's (and others') general knowledge of the consequences of individual initiatives.

As for the initial studies the scope of after-studies should be restricted to what is required and adequate. For small changes this should include

- monitoring and evaluation of the behaviour of different road user groups
- measuring traffic flow for all road user groups

- measuring mean speed and speed distribution for motor vehicles
- recording of accidents

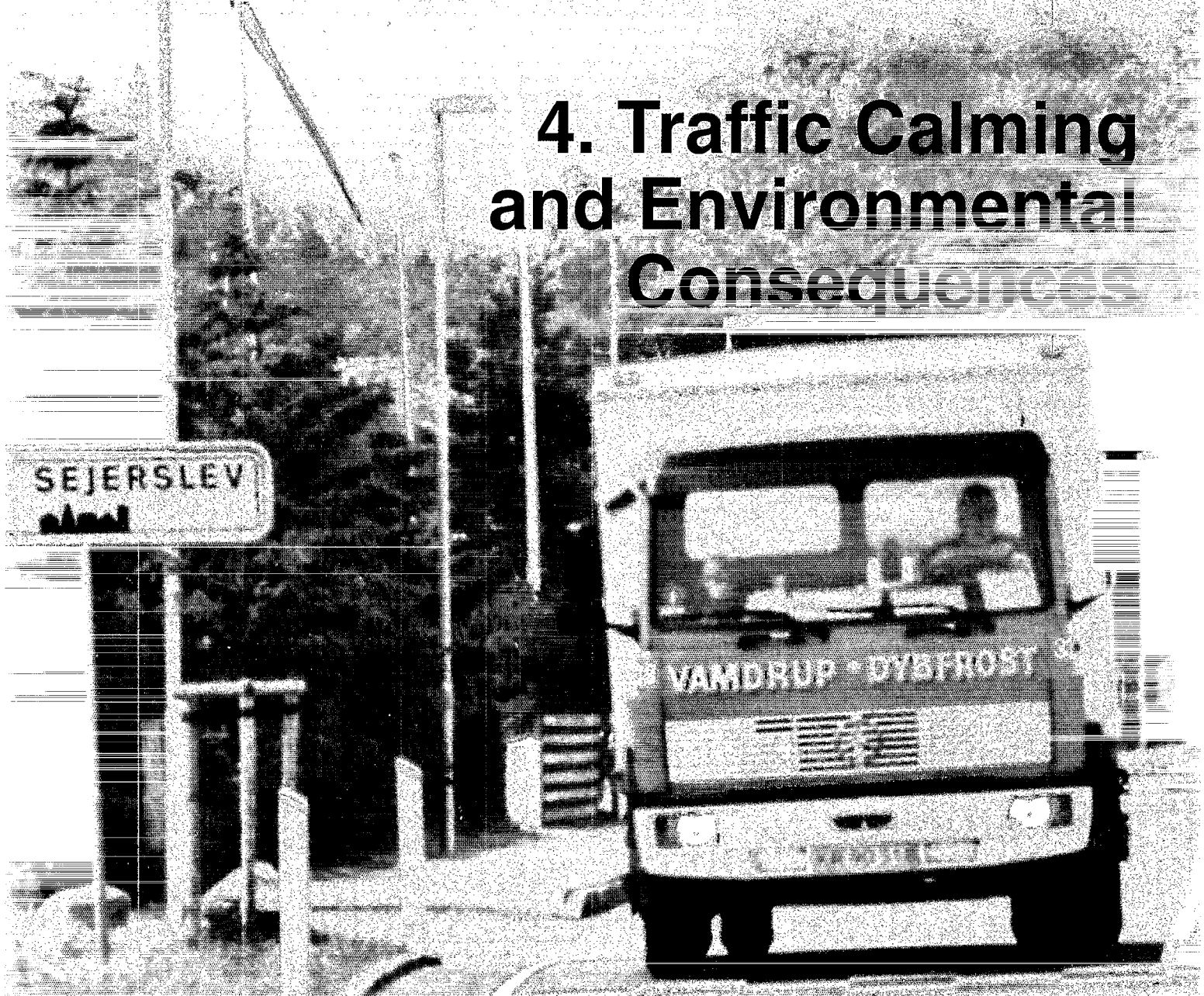
Depending on the purpose of the traffic calming other factors may be recorded, such as noise and air pollution.

For major changes of the traffic network, or perhaps in connection with the first changes of a particular type, it may also be expedient to monitor the response of residents, road users, and others.

Considerable inspiration can be found in the consequence evaluation reports for environmentally adapted through roads in Vinderup, Skærbæk, and Ugerløse *(11, 12, 13)*.

The speed should be measured before and after the redesign.

4. Traffic Calming and Environmental Consequences



Changes in Traffic

The list of examples in chapter 9 includes both changes that have reduced the volume of car traffic, conversions that have lowered car speeds, and changes that have had both effects.

To offer an overall framework for evaluating the possible effects of traffic calming this chapter describes a number of general experiences of what can be achieved. The description has been simplified inasmuch as it treats the reduction of car traffic volume and car speeds separately.

For each of the examples in chapter 9 an account is provided, to the extent possible, of the effects achieved - both the primary effects (reduction or redirection of car traffic, speed reduction) and the derived effects (safety, the environment, public attitudes, etc.).

Chapter 7 on the techniques of speed reduction describes how each of the listed measures can contribute to obtaining the desired effect.

Reduction of Car Traffic Volume

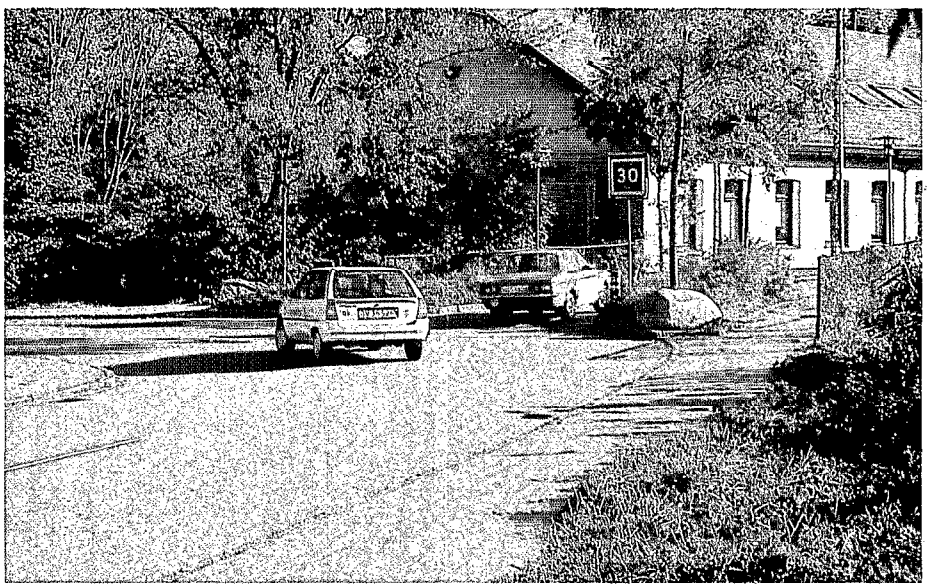
The planning principle which says that the urban road network should be divided into two road classes, traffic roads and local roads, will, if observed, result in a number of roads being declassified to local road status and hence freed of part of the motor vehicle traffic.

This may apply to whole town areas such as the town centre or to a continuous residential area, or it may apply to individual roads. The means to reduce the traffic may be road closures, speed reducers, or combinations of the two.

Traffic Safety

Logically, a reduction of the car traffic volume on a road will normally result in a fall in the number of accidents on the road, provided the speed level is unchanged.

In most cases, however, the reduced volume will be caused by a redirection of the traffic and therefore be offset by increased traffic on other roads. So, before the conversion it should be considered whether such alternative routes are better suited for traffic than those relieved.



A speed reduction can make some car drivers choose other and better suited roads.

Normally, of course, such rational considerations underlie the projects that are implemented. Indeed, the general tendency is that the improved safety on the traffic-calmed streets is not counterbalanced by a correspondingly higher number of accidents on the streets with intensified traffic.*(8)*.

Security

Rational planning and a considered identification of the roads that have to be traffic roads will also mean that the calming of the local roads increases the light road users' feeling of security. A reduction of the heavy motor vehicle traffic has especially proved to increase the feeling of security considerably.

Fence Effect

It should be mentioned, however, that the calming of traffic, and the partitioning of the town into peaceful enclaves as a consequence of the division into traffic roads versus local roads, may result in traffic roads becoming barriers between the individual enclaves. The possibilities for crossing the traffic roads should therefore be carefully considered.

Noise

Other things being equal, by halving the car traffic on a stretch of road the noise level is reduced by 3 dB(A), i.e. just perceptibly.

Relieving many local roads of small, but relatively significant traffic volumes can therefore produce considerable improvements of the conditions along these roads. By contrast, the corresponding, but relatively small increase of the traffic on the few traffic roads, will only increase noise levels slightly. Thus, redirecting the car traffic can produce a considerable overall improvement of noise levels *(26)*.

Air Pollution

Because the emission of gases and particles, other things being equal, is proportional to the car traffic volume, a reduction of the traffic will entail a proportionate improvement of the local air pollution *(27)*.

If the reduction is caused by a redirection of the car traffic, the aggregate pollution will not decrease. Nevertheless, the total impact on the light road users and the residents will be reduced, provided the plan has been thoroughly thought through.

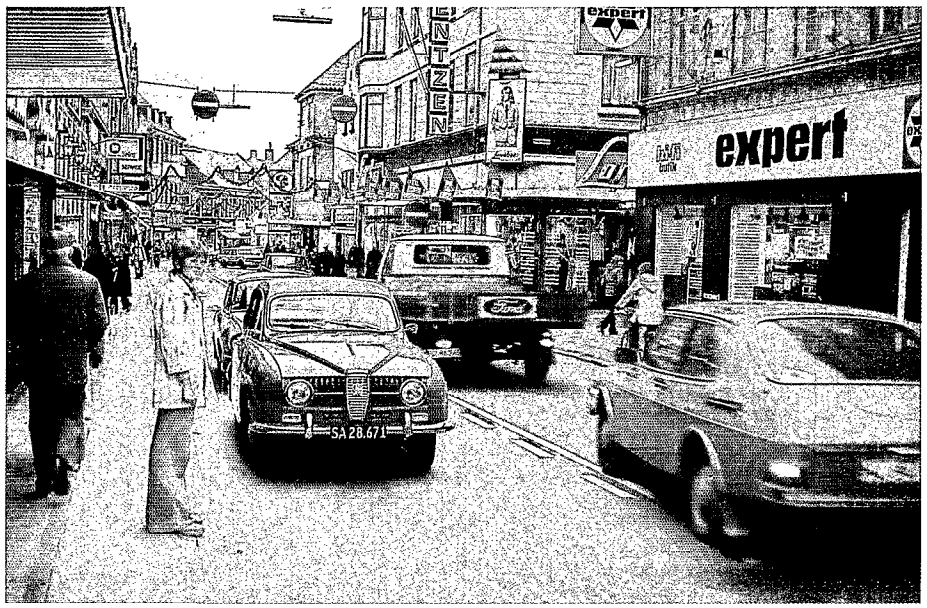
Energy Consumption

Other things being equal the energy consumption is proportional to the distance covered. Redirecting the traffic will therefore not in itself reduce the energy consumption and the CO_2 emission, but may even, if detours take place, result in higher consumption.

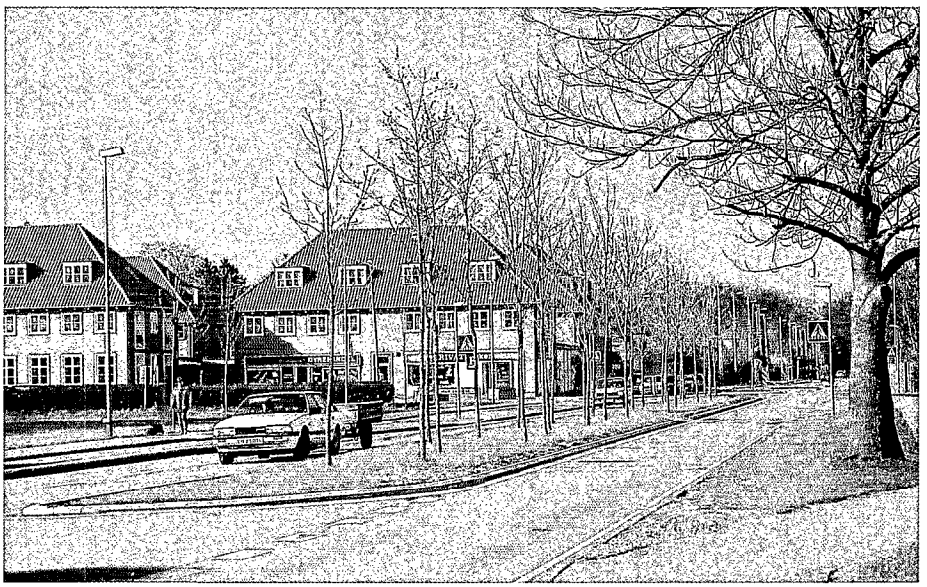
Public Attitudes

Residents', road users', and other people's response to the changes is as important as the measurable results. In this connection it should be realized that allowance has to be made for many different groups of people with a range of different interests.

Clashes of interests appear especially in central urban areas. Here, some residents, environmental organizations,



The through traffic on this local road -



- should be transferred to this traffic road

Divided track. The cyclists' and cardrivers' feeling of security has increased. Pedestrians' feeling of security is more debatable.

tourists etc. will often welcome a reduction of car traffic whereas other residents and the shopkeepers will often oppose it.

Consequently, balanced solutions should be sought in which the desired calming goes hand in hand with a reasonable accessibility - for handicapped people, for shopping, etc.

When such considerations are made, the results usually prove that the shopkeepers in particular are far more positive after the traffic calming than they were before.

Reduction of Car Speeds

Also speed classification, and later enforcement, on individual roads or in whole precincts will produce a number of positive effects.

Traffic Safety

Speed and the risk of accidents are very closely linked. Indeed, experience shows that considerable improvements can be achieved by lowering speeds.

On local roads the frequency of accidents is normally so low both before and after the redesign that it is difficult to extract significant results concerning the improvement of safety in the individual street or area.

However, against the background of studies of a total of 44 redesigned roads (silent roads and shared areas) the Traffic Safety Research Council has found a reduction of the frequency of accidents of 72 per cent and a reduction of serious injuries of 78 per cent *(8)*.

These very positive results are confirmed by other studies for example in Germany and France.

Also on traffic roads substantial savings can be achieved in terms of accidents, and especially personal injury, by reducing speeds. In addition, the consequence evaluation of environmentally adapted through-traffic and other studies show that the reduction of accidents depends very much on the detail design of the speed reducers, and that in certain cases further improvements may be obtained from small changes of the original design *(14, 28)*.

Security

People's feeling of security when using a road depends very much on which road user group they belong to *(29, 30)*. Experience shows that the pedestrians' feeling of security increases substantially when speeds are lowered. The same goes for parents' ease of mind in letting children go out on their own.

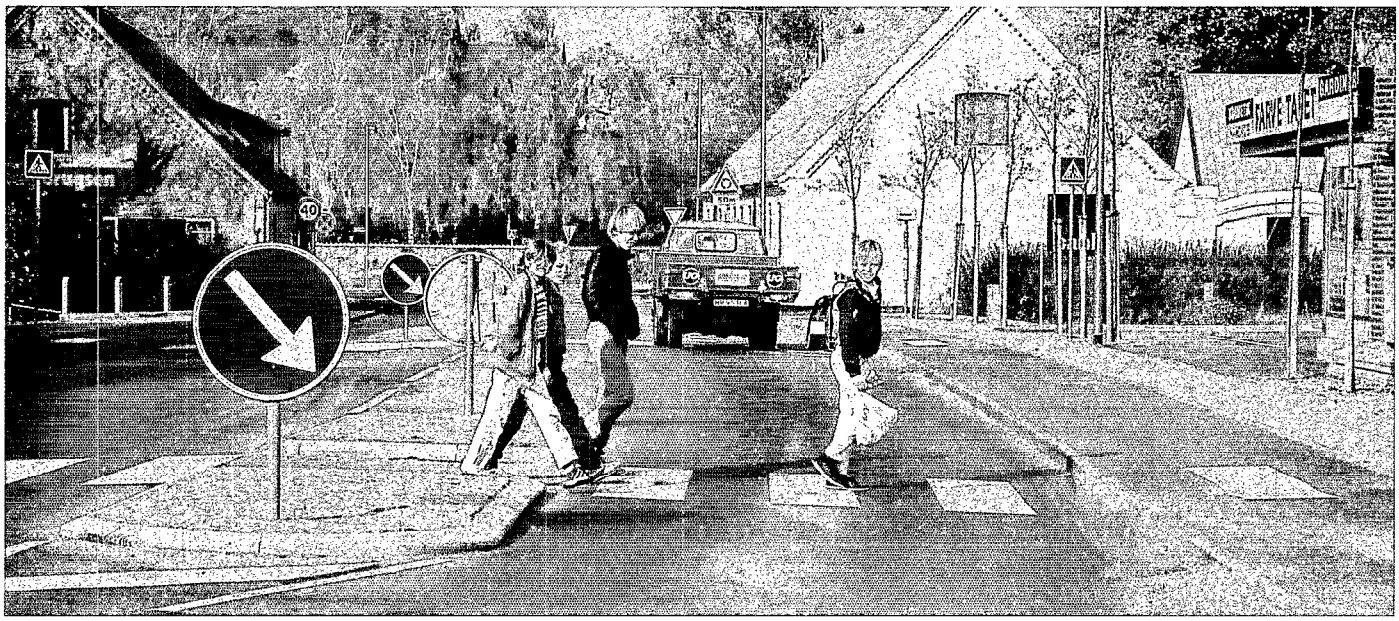
Cyclists' description of their feeling of security varies more. The main tendency is that security is enhanced as car speeds are reduced, especially if a given scheme includes the establishment of bicycle tracks. If there are no such tracks, the cyclists' evaluation depends much on the design of the speed reducers, on the physical distance between bicycles and cars, and on the difference in speed between them.

Car drivers' evaluations of security varies, but they tend to find that their own feeling of security has suffered because of the speed reducers.

Bus passenger and bus driver attitudes have only rarely been studied, but tend to express clearly that the speed reducers, in the form of both humps and staggerings, reduce comfort.

Fence Effect

Especially the outcome evaluations of environmentally adapted through traffic show that speed reduction on a road



Speed reduction lowers the fence effect of the road.

may entail a massive increase in the number of people who use the road and the number of cyclists and pedestrians who cross it.

Additionally, measurements of delay times show that the reduction of car speeds saves some time for crossing road-users, and interviews with pedestrians and cyclists reveal marked improvements in security *(11, 12, 13)*.

Noise

Measurements and calculations in conjunction with various conversion projects demonstrate that by lowering the car speeds general reductions of the noise level can be achieved in the order of 1-3 dB(A), i.e. from the barely perceptible to the just perceptible *(11, 12, 13)*.

On the other hand a higher number of accelerations and decelerations can increase the noise level, so consequently it is important to aim at an even speed profile *(31)*. Local noise problems can also appear for example where vehicles pass over rumble strips or carry loose goods over humps *(32)*.

Air Pollution

Measurements and calculations in conjunction with conversion projects have identified small changes of car-related air pollution in both positive and negative directions.

Generally, however, it must be noted that a reduction of car speeds in most cases will have no great influence on air pollution. Recent studies, though, indicate that speeds and air pollution are related in urban areas inasmuch as a speed reduction can result in a small increase in air pollution *(33)*. But as in the case of noise emission, the more even the driving pattern, the more air pollution is reduced.

Energy Consumption

Both energy consumption and CO_2 emissions follow the pattern described under Air Pollution above.

Public Response

The residents along a road, in a precinct, or in a town are often likely to judge the overall effects of a traffic calming. If they are generally satisfied, they will evaluate all or at least most effects positively, also beyond what can be objectively registered. Experience shows that such general satisfaction is particularly linked to whether or not people feel that

- they have been consulted
- the visual environment has become more attractive

Consequently it is important, not only for the individual project but also for the public attitude to traffic reorganization generally, that the public is involved in the planning as described in chapter 3 - and that planners do not confine themselves to the preparation of projects that are technically adequate and safe, but that they also expend the required resources on creating an aesthetically pleasing road space.

5. Traffic and Urban Architecture

The Competition for Urban Space

Through centuries, our towns and cities have been characterized by density, and hence limited outdoor areas. In these limited areas two objectives have always had to be provided for - traffic and leisure.

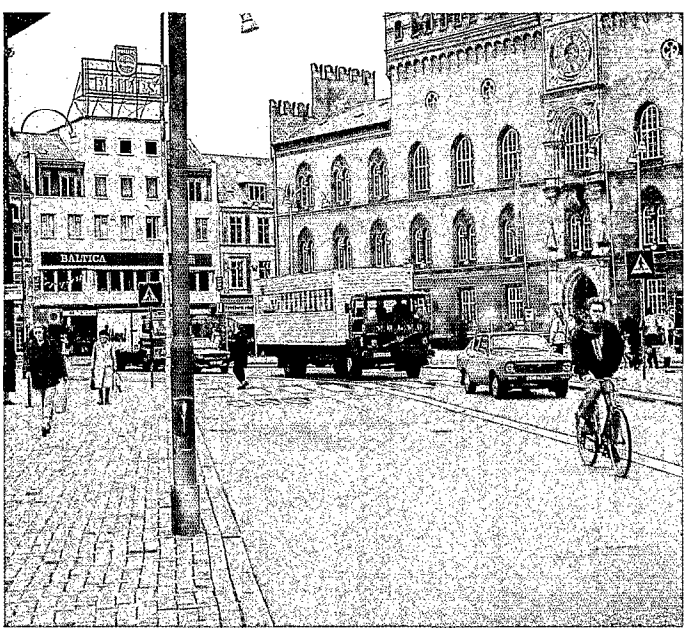
This was feasible for as long as traffic was modest. But along with the increasing motor car traffic of our century the competition for space has become keener and to a great extent car traffic has come out victorious.

The result has been traffic congestion in the old parts of towns and extensive spatial concessions made in favour of motor vehicles in the new urban areas, which has led to open and not very town-like environments.

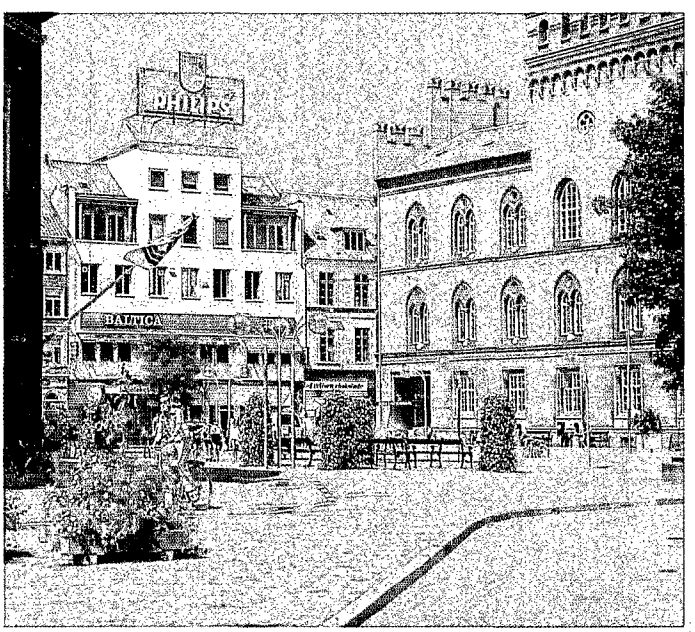
However, the internationalization of the last decades, the growing tourism, and the inspiration from towns south of Denmark have created an intensifying interest in using urban spaces as public areas for a large variety of activities such as trade, exhibitions, entertainment, music, etc.

The Vanished Unity

Until car traffic made its mark on towns, there was often a natural interplay of streets and buildings. Surfaces displayed a characteristic unity and the design of town fixtures was made to a high standard of craftsmanship. There was a clear functional and visual division into squares, street spaces, and private yards, and the street pattern was determined by ground configurations and property-lines with ensuing variation and manageable dimensions.



Vestergade in Odense, 1985.

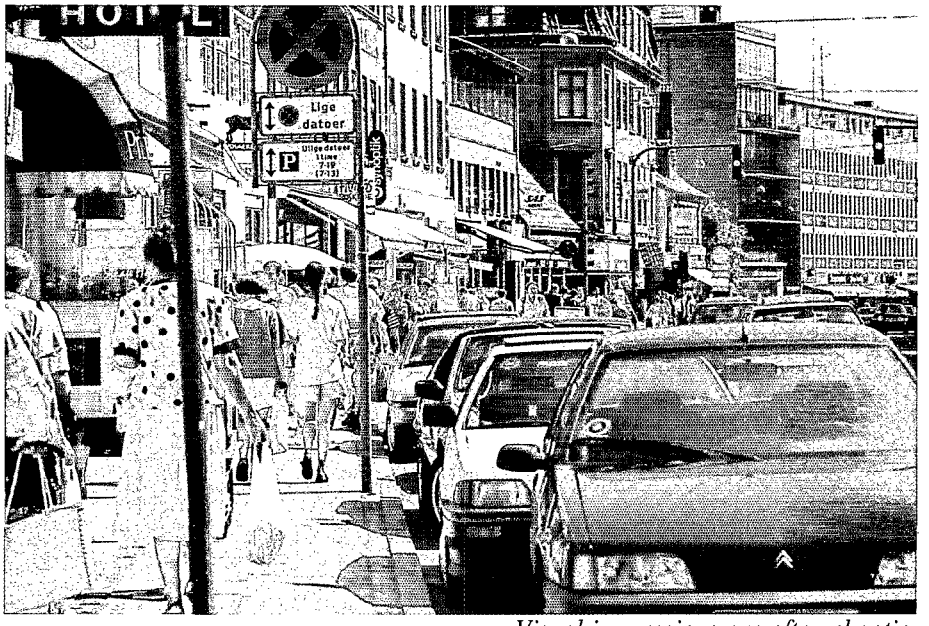


Vestergade in Odense, 1992.

The development of traffic has changed this picture. Requirements of accessibility and an easy traffic flow have forced houses, trees, front lawns and backyards to give way to road extensions, street penetrations, and carparks.

The street scene is dominated by billboards, road marking, road signs, casually selected street lamps, etc., adopted haphazardly when needed, with no overall planning and often with a lack of respect for existing conditions. The sense of unity has slowly disappeared and the urban scene has become fuzzy and diffuse.

This transformation of our towns has been permitted to take place since, for a number of years, there has not been a sufficient awareness of the total visual consequences of car traffic development and increased commercialization.



Visual impressions are often chaotic.

New Trends

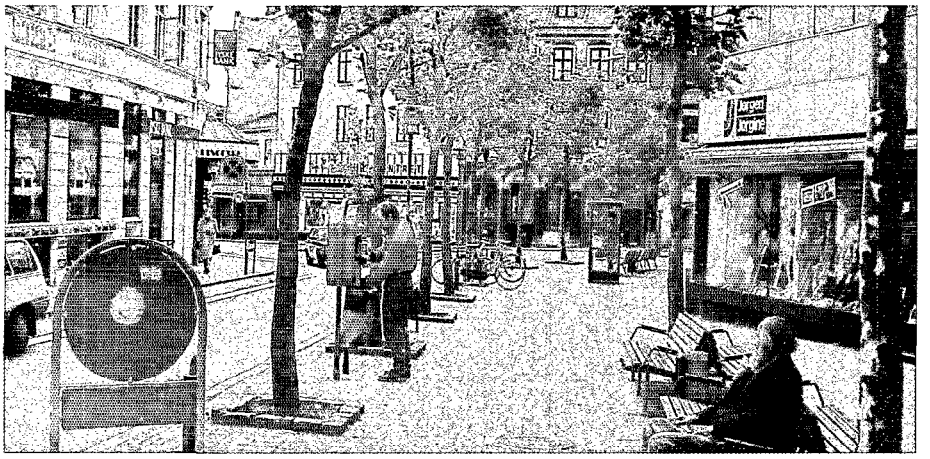
In many towns this development is now being challenged.

Simultaneously with a strongly growing awareness of pollution, traffic safety, and security there is an increasing understanding of the visual environment and its importance for the inhabitants' quality of life *(34)*.

There is a growing acceptance of the necessary balance between functional and visual considerations, and there is a growing consensus on the importance of conserving and recreating the qualities of urban public spaces. Very often, fortunately, traffic calming and improved safety, pollution abatement, and improvement of the visual environment can take place simultaneously, provided only that all factors are considered in a coherent plan for the given town or urban area *(35)*.

Logically enough, the changed attitudes have had an initial stronghold in central parts of towns. Generally this is where the historically and architecturally most interesting buildings are located and where we find the streets and squares that are particularly characteristic.

In residential areas beyond the town centre the trend is less pronounced. A large number of traffic calming schemes have been undertaken, but not all are equally successful from the point of view of urban architecture.


Our town centres have become much more beautiful -


- and so have many residential roads.

Unfortunately, the urban periphery has been largely neglected, especially the big entry roads and their surroundings. Visitors' first impressions are therefore often chaotic and uninviting.

Good Urban Spaces

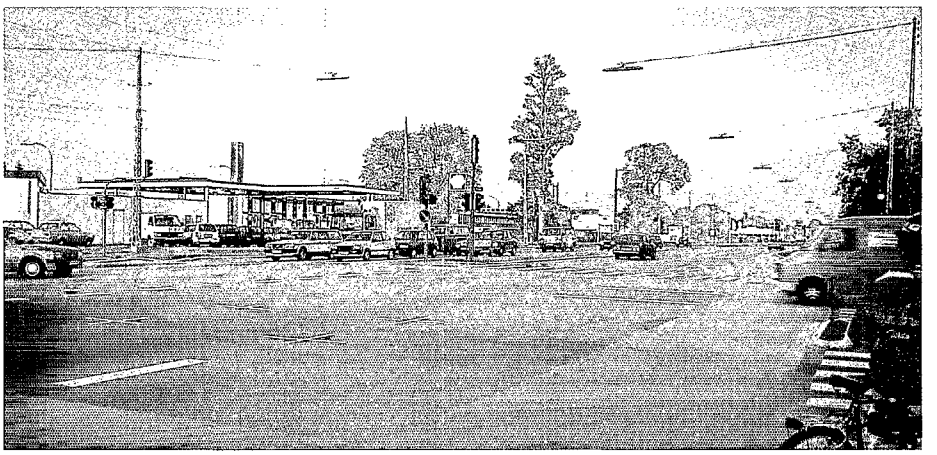
What is a good urban space?

Firstly: it is not necessarily free from cars. In other words, the efforts to create beautiful surroundings for town users should not be restricted to pedestrian precincts etc.

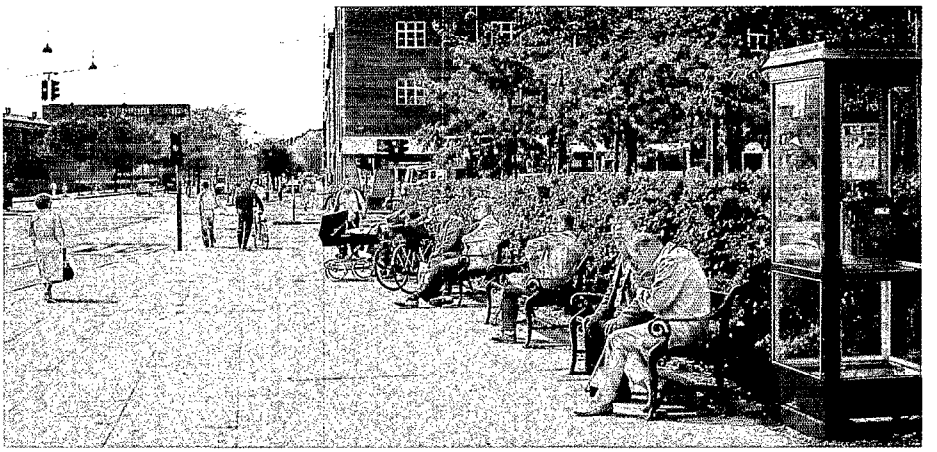
But secondly one must ask who is to experience the urban space and at what speed. Pedestrians move slowly and their visual field is large. Therefore they get a totally different impression of buildings and street-space elements than cyclists and, especially, drivers.

A stretch of road is also perceived differently depending on whether one is moving on it or looking at it from the surroundings. People's age, profession, their business there, and handicaps, if any, are also important for determining impressions.

It is hardly possible to lay down universal rules for the definition of a good and beautiful street space. A fundamental if not very precise rule might be that a harmonious street space is one which appears varied, yet unified.



A typical entry road.



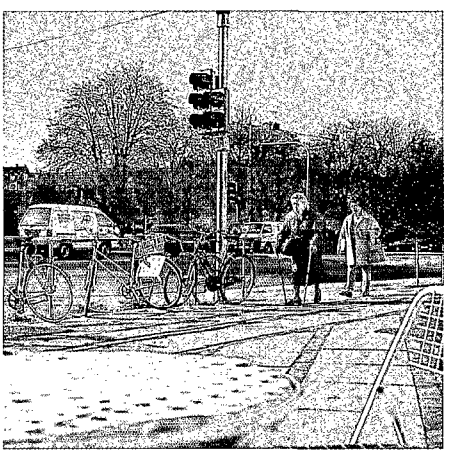
A view to the car traffic can be an attraction.

A unified whole may well be composed of many different constituent elements. For example a front of houses, each with their own individual characteristics, but which in terms of proportions, materials and colours are part of a consistent whole.

So a harmonious mutual interaction between the elements of urban space is important. However, if one focuses too much on this, the street scene may become so nice and uniform that it appears almost dull.

In connection with traffic calming one should therefore also have an eye to the possibility of creating exciting effects by contrasts. Within specified limits

The sitting person, the pedestrian, and the driver each have their own impression of the street scene.



there should be a reasonable margin for the imagination. And by working with the details, harmony should avoid dullness.

Design Manuals etc.

As part of the effort to make towns more attractive a number of municipalities have prepared design manuals and green plans. Also the municipal road sign and lighting plans should be seen in this context.

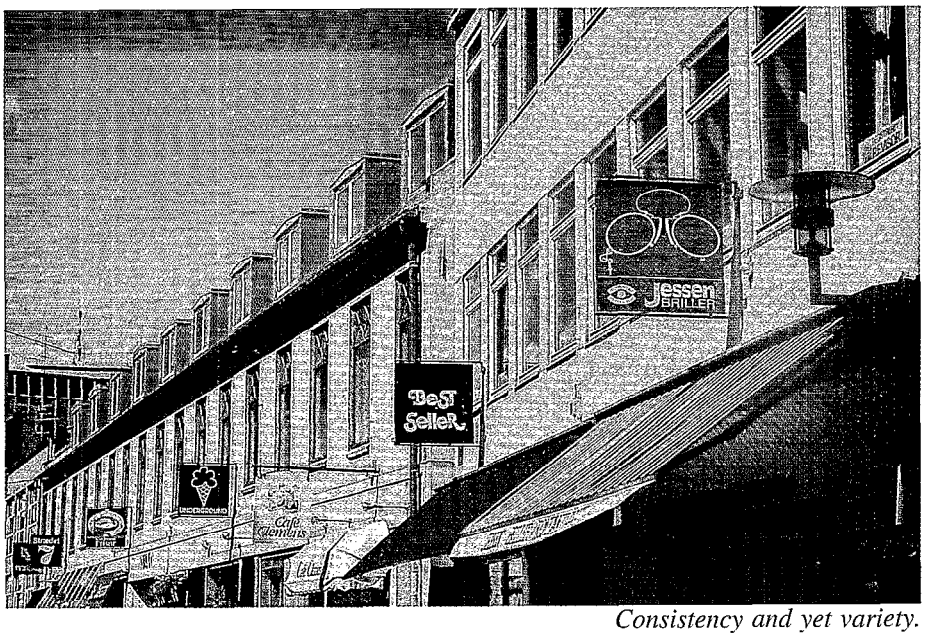
Among other things a design manual may include instructions on siting and design of signs, surfaces, lighting, plantings, facades, street equipment, and objets d'art.

A reasonable balance should be struck between uniformity and variation. For example, a certain, consistent architectural policy could be sketched out for an entire municipality or town, but supplemented by the possibility of forming and equipping individual town spaces in accordance with their history, the age and architecture of adjoining buildings etc.

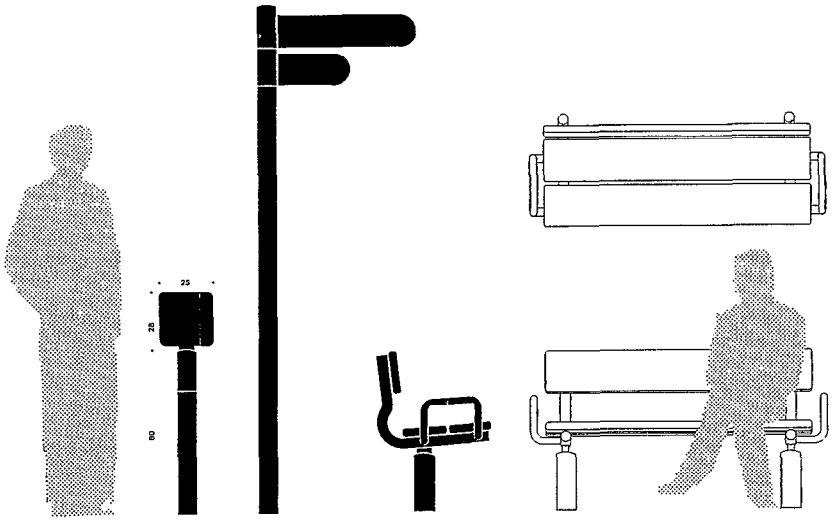
A green plan can provide guidelines for planting in street spaces, layout, choice of types and species, maintenance etc.

Here again the balance between uniformity and variation should be found. For example, the traffic structure of the town can be emphasized by identical plantings on all major roads. Or the characteristics of the different areas can be emphasized by individual planting schemes.

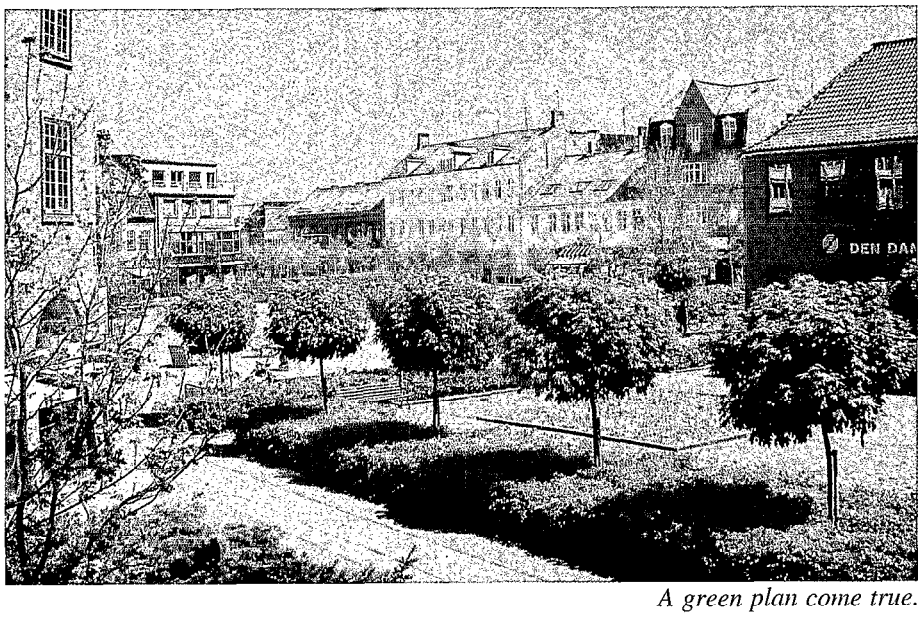
A road sign plan defines where which signs are to be placed. With respect to the visual environment the plan should first and foremost contribute to a reduction of the number of signs to the required minimum, and secondly specify marking whose size, design, and position matches the desired appearance of the street space.



Consistency and yet variety.



From a municipal design manual (36).



A green plan come true.

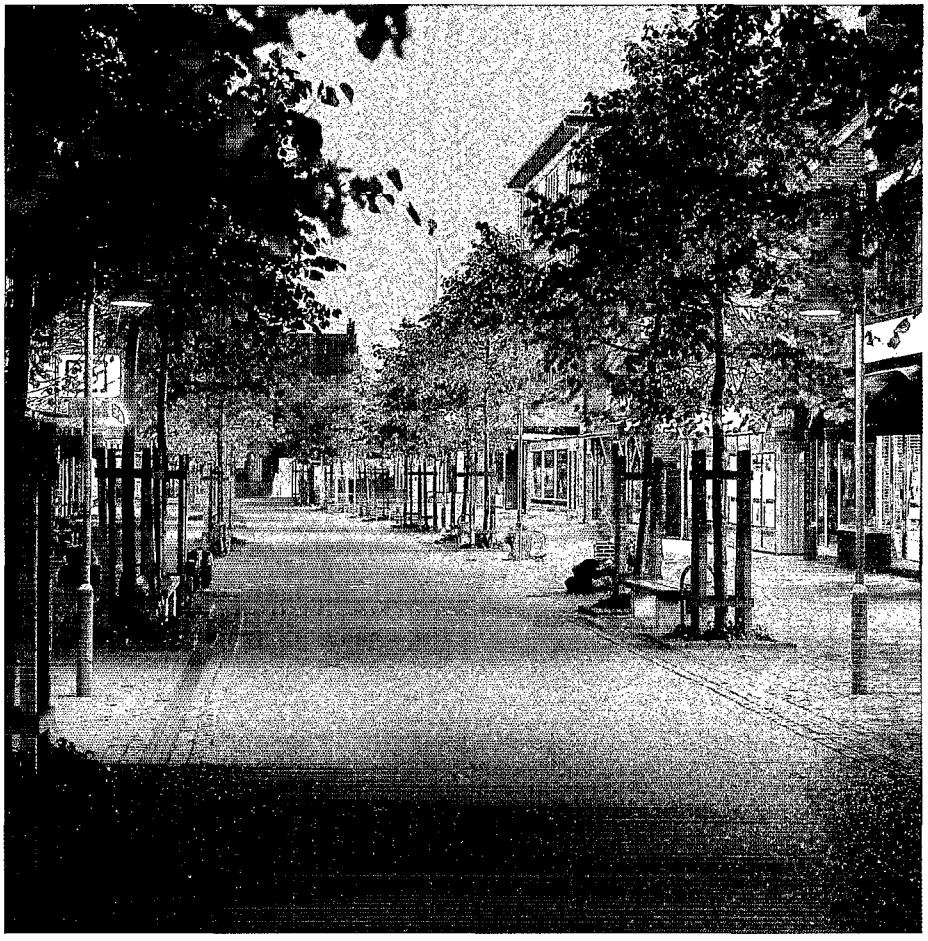
A municipal road lighting plan specifying guidelines for alteration of existing systems and for the choice of new ones should not only include purely technical requirements, but also instructions on siting and choice of posts, pylons, and lamps with regard to the ambiance of the individual urban spaces.

Traffic Management by Design

The expression 'traffic management by design' means that the traffic is controlled primarily by the design of the street and the street space rather than by road signs and road marking *(37)*.

The basic form, the surfaces, plantings and lighting of the space, the position of street equipment, etc. should tell the road users not only where the carriageways, parking areas, pedestrian and public zones are, but also where drivers should pay special attention to pedestrians and what speed is most appropriate in that particular place.

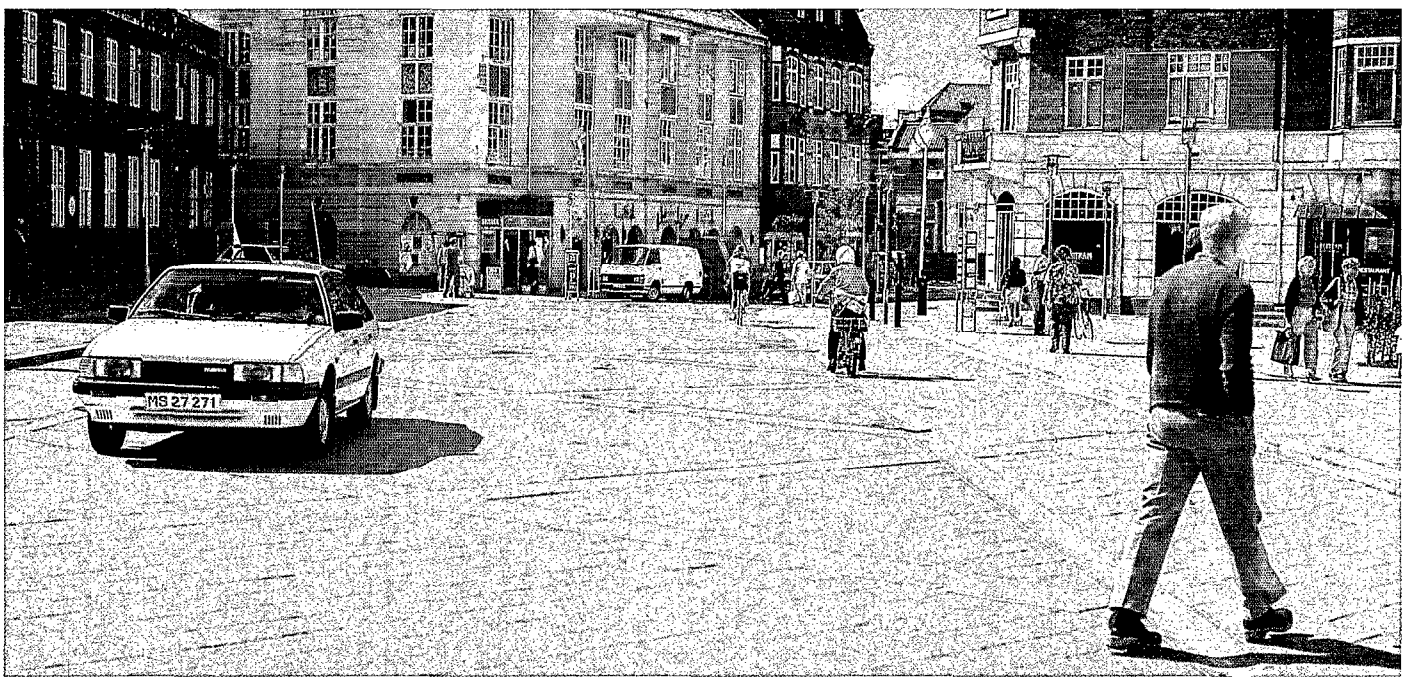
In this way the use of signs and road markings can be reduced, for these elements are rarely visually pleasing and, even so, are also often insufficient in regulating traffic.



A fine result of a good street lighting plan.

In the most successful cases two things can thus be achieved with the design of the urban space and its traffic and public areas: Firstly, a visual environment with good experiences for those who go there. Secondly, road user behaviour which enhances the possibility of not only being on the road, but also of experiencing the environment *(66)*.

Traffic management by design.



6. The Elements of Urban Space

Urban Space

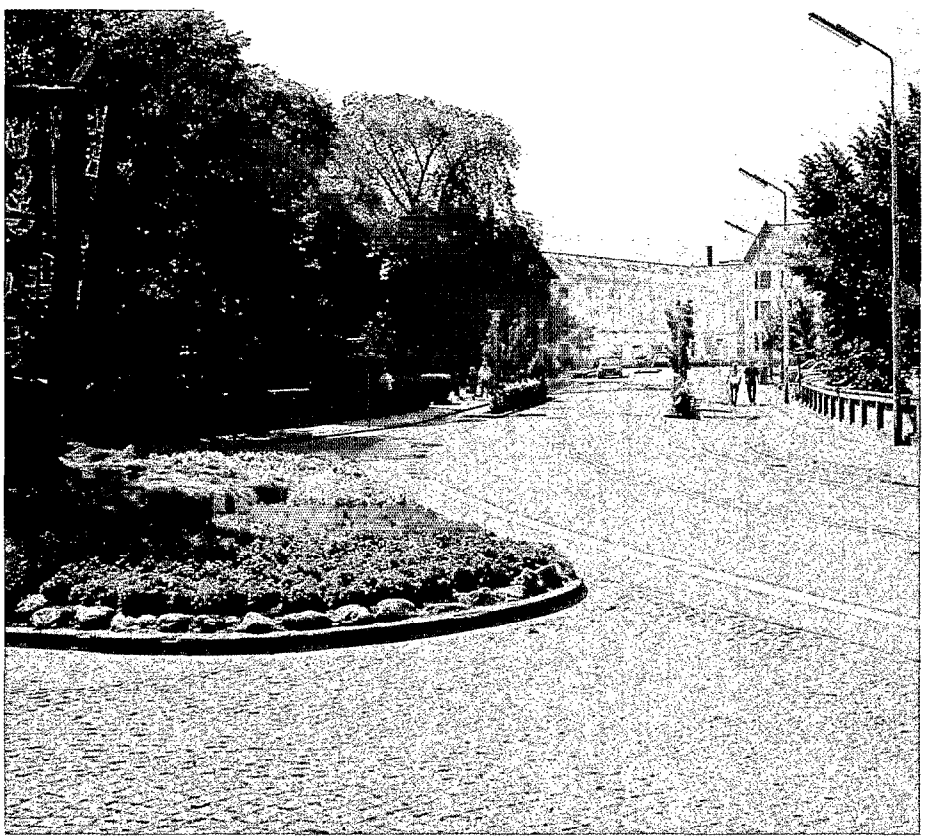
The perception of the urban spaces - road spaces, street spaces, squares and open spaces - is determined partly by the surfaces surrounding them (floor, walls, and ceiling), partly by the spaces themselves, their sizes, shapes, partition, and contents *(23)*.

The floor of the town space is first and foremost the paved areas but also low-growing vegetation such as grass borders, bushes, or flowers.

The walls are constituted not only by facades, but also by walls, fences, and various types of plantings.

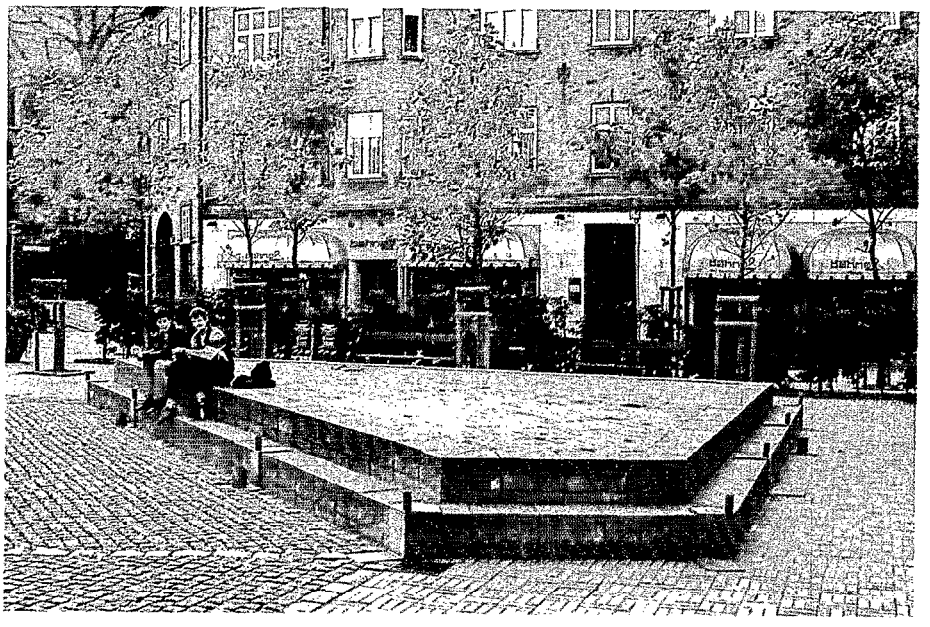
The ceiling is mainly the blue or overcast sky. But it is possible to add more or less to the experience of space by a conscious use of lighting, plantings, and in certain cases complete or partial roofing.

The room as such is defined by the floor, walls, and ceiling, but the furniture and the relative division of the space also play important roles both from the point of view of traffic, and visually. The furniture of the street space are signs, lamp posts, plantings, and other street equipment, including also actual furniture.



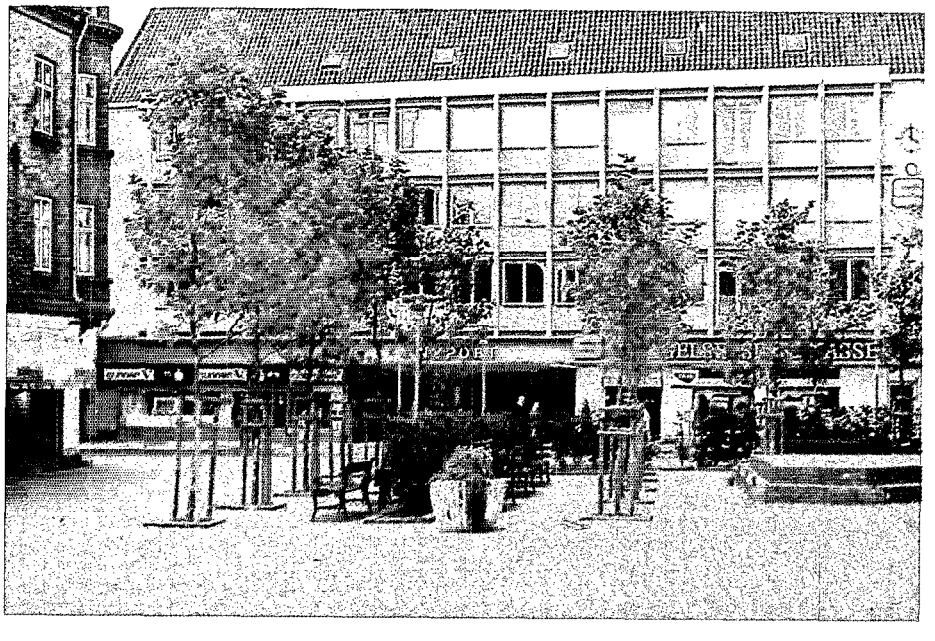
The floor of urban space is constituted mainly by the paved surfaces, but also by low vegetation.

Not only the house fronts, but also brick walls and various kinds of plantings make up the walls of urban space.



The crowns of trees form the most beautiful ceiling over an urban space.

Only when furnished does an urban space become more than a mere traffic area.



Road Surface

The road surface must make it clear who is to use which area, and can especially indicate the transition from public to private areas. In addition it can help to reduce car speeds and in other ways signal appropriate behaviour.

The individual road user groups experience the road surfaces very differently. Pedestrians' and cyclists' visual field is naturally directed slightly downwards and to them the road surface is therefore particularly important for the total experience of the space. And of course quite special precautions should be taken for different groups of handicapped people.

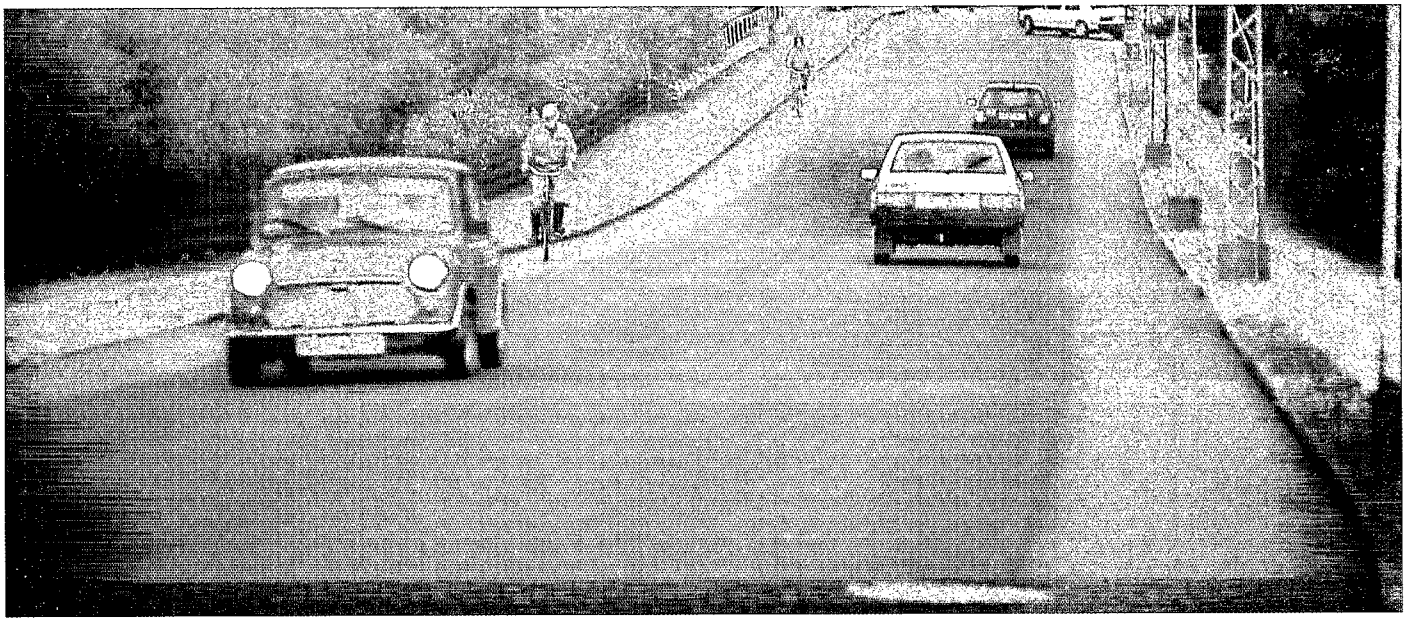
A conscious choice of road surfaces can underscore the nature of the space and have a unifying effect on an otherwise blurred street scene. However, this requires both a regard for adjacent buildings and a certain uniformity of materials.

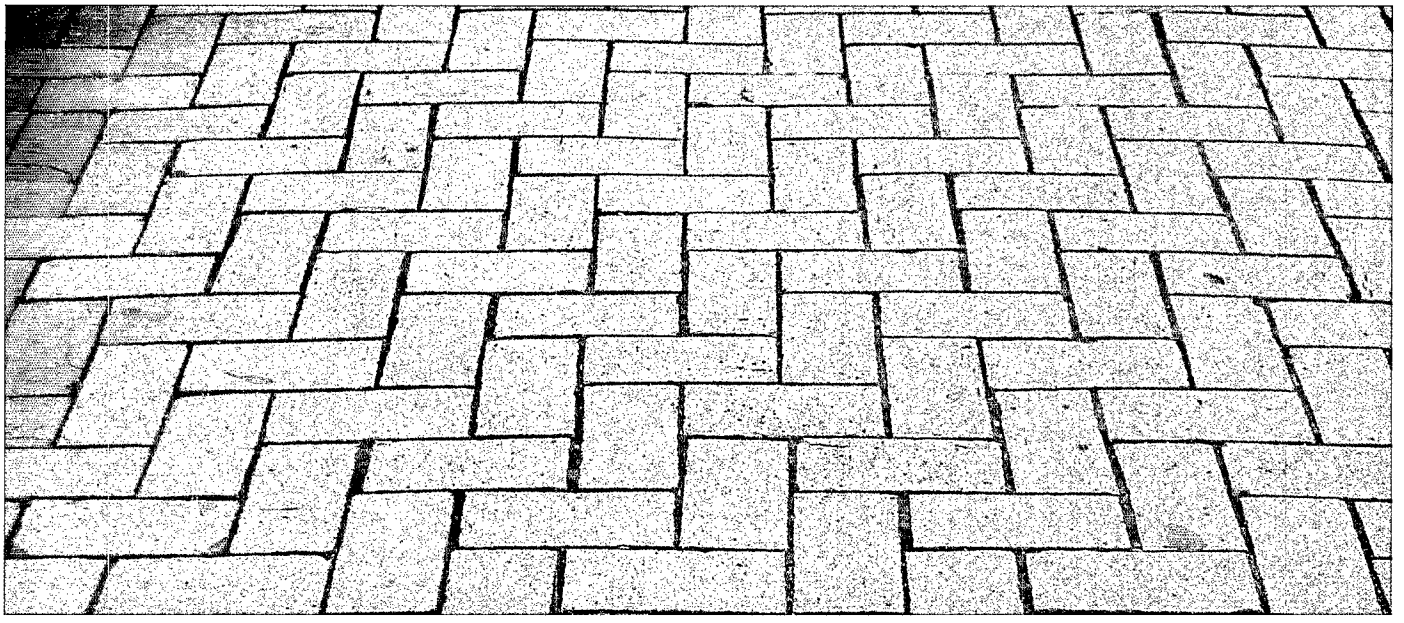
Variation of the road surface should therefore be obtained through formats, patterns, bonds, and surface textures rather than through many different colours and materials.

For practical and economic reasons durable and of course solid surfaces should be chosen, preferably ones that will acquire an attractive patina over time.

Finally it is important to make sure that replacements can later be made with the same material and with the same look.

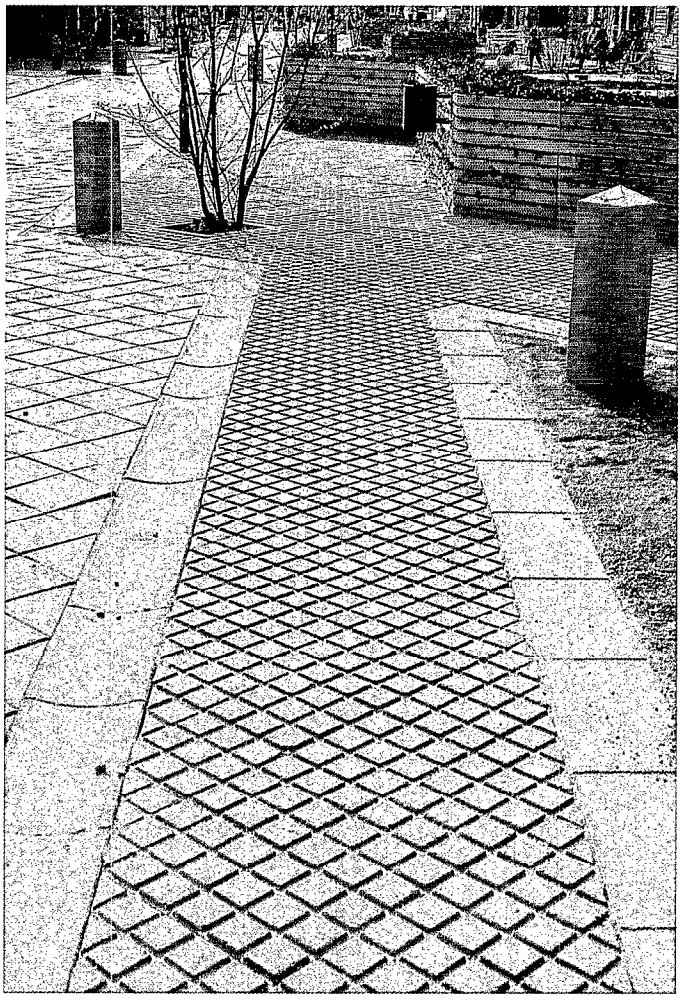
On areas devoted to driving traffic, asphalt will still be the most widely used surface material - also in conjunction with traffic calming. By using different colour chippings attractive effects and good adaptation to other surface materials can be obtained.



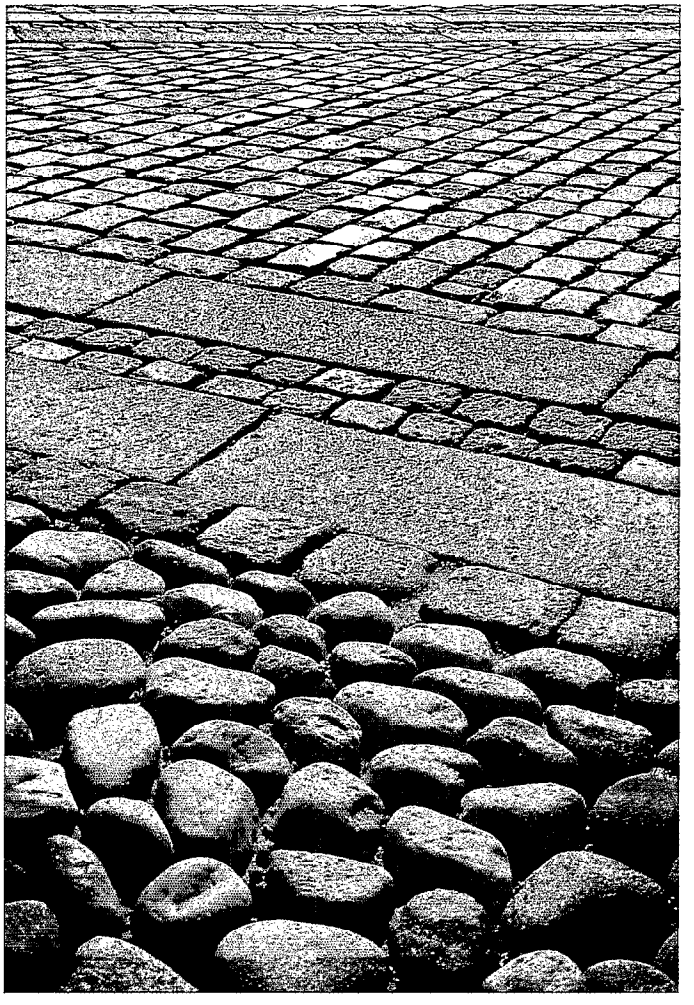


Hard burned paving brick is a traditional surface material and therefore often well suited where a former environment is to be recreated.

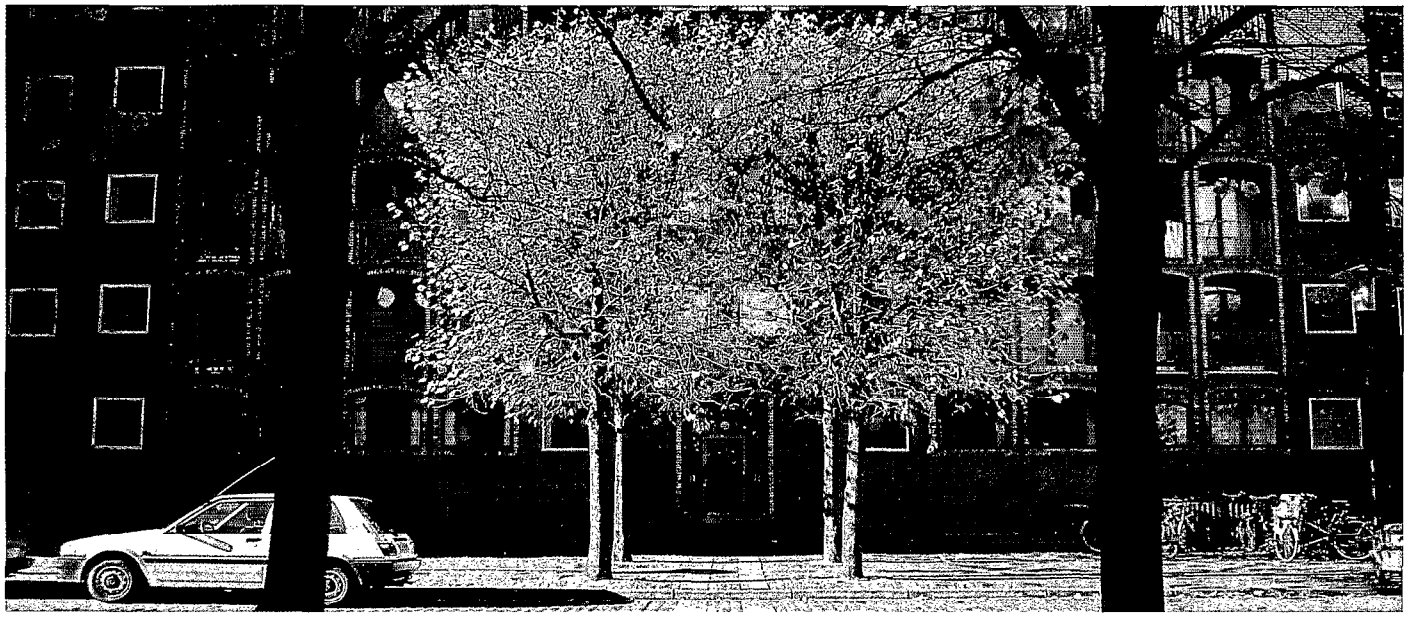
Concrete paving stones are available in many shapes and colours and are therefore very practical where a certain distinction must be made in pedestrian zones between areas for different uses such as walking, driving, parking, etc.



Granite is beautiful in itself and to a certain extent also has a speed reducing effect. It is therefore very suitable in connection with traffic calming - provided it is taken into account that cobbles create wheel noise, are difficult to walk on in high heels, and are completely unsuitable for bicycle traffic.



Plantings



Plantings can be a very important element in a town space. It can make up walls, floor, and ceiling, and it can appear as street furniture or as an embellishment of the space.

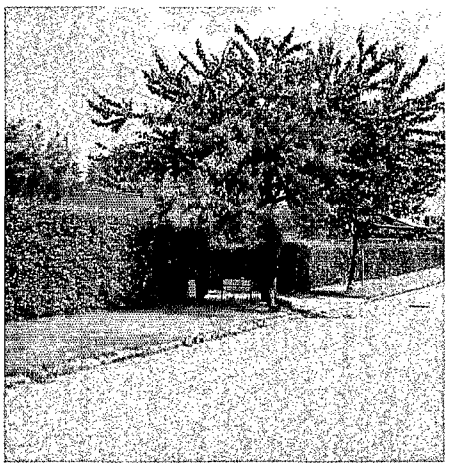
Trees can be used as solitary trees, portal trees, in groups of trees, patterned plantings, lines of trees, and on avenues. Bushes can be utilized for hedgerows and as scrub. Finally, the ground cover can be grass borders, shrubbery, or flowers.

The plantings can take on a direct traffic-related function, as a gate, a visual narrowing of the space, or as a marker of speed reducers.

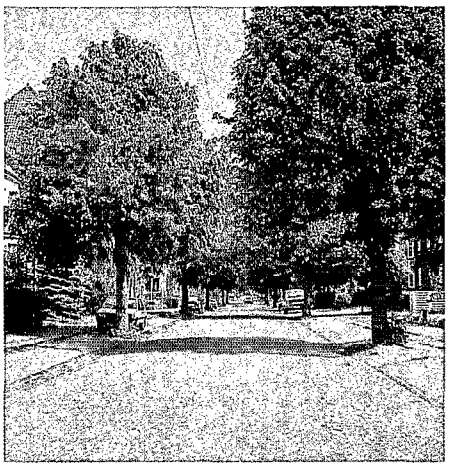
It can also have a mission in its own right - emphasizing a space or a pattern, screening off, being a sculpture or an embellishment.

In certain cases local traditions will form a good background for choosing methods and species for plantings. There might also once have been a characteristic planting which one may now be able to reestablish.

However, one should be cautious not to plant excessively for visual effect. Some streets and squares are better suited for a strictly urban design, with hard surfaces and no vegetation. In other places a solitary tree will, if placed correctly, produce a better impression than many more haphazardly placed bushes and flower cribs.

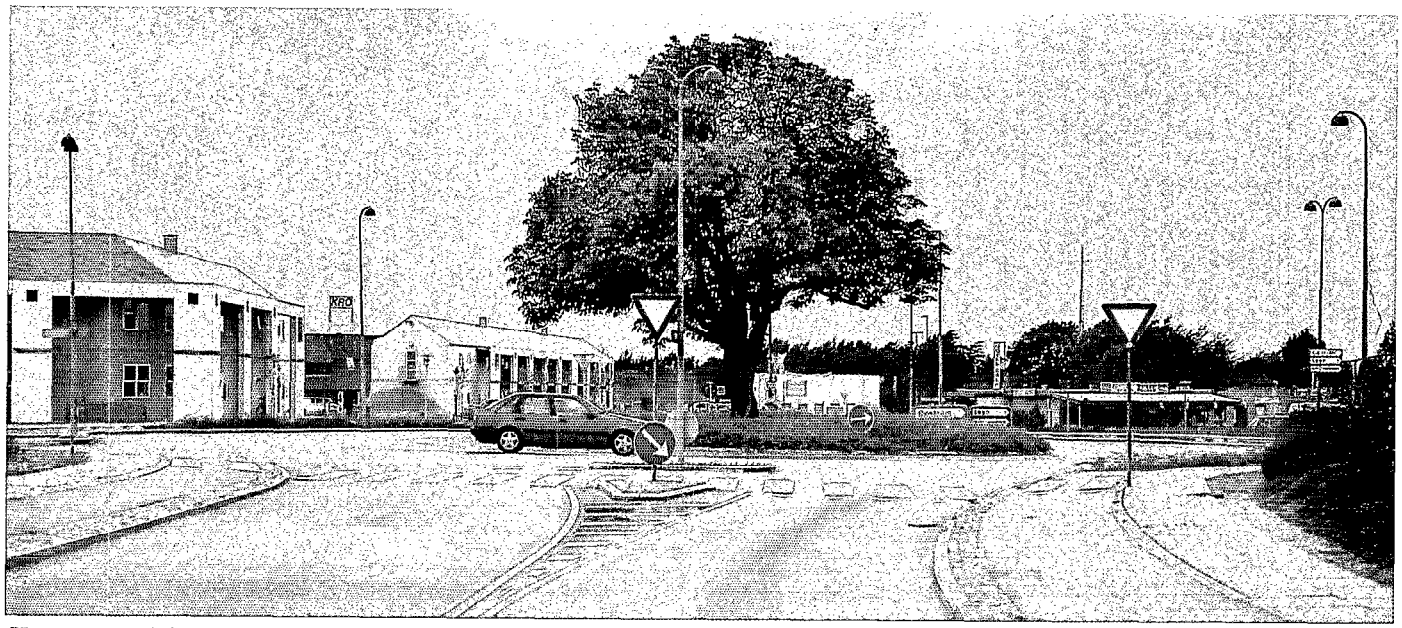


Here two trees form a gate indicating the transition from a traffic road to a local traffic area.



The planting makes the road seem narrower and therefore functions as a speed reducer.

The tree marks the hump, enhances the speed reducing effect, and ensures that the hump does not appear as a surprise.

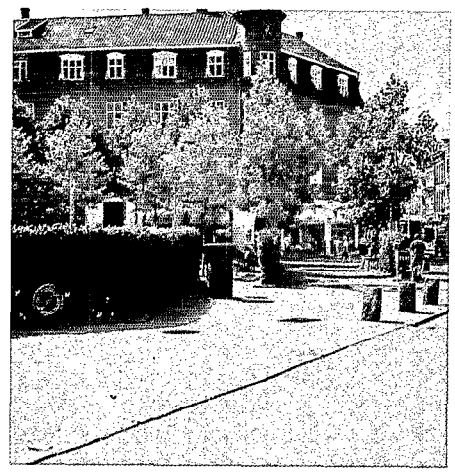


Here a roundabout is visually emphasized by the very beautiful newly planted tree.

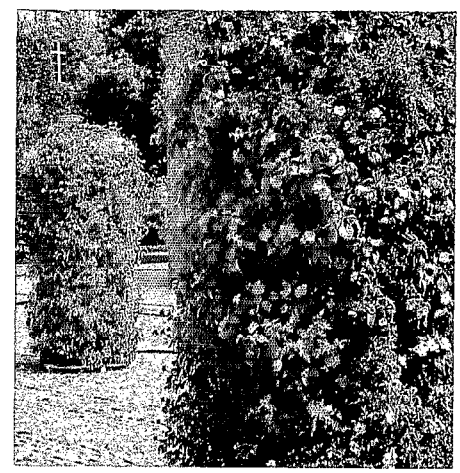
The trees both regulate traffic and adorn the road.

The patterned planting forms a beautiful ceiling over a parking area.

A trunk hedgerow can temporarily or permanently close a gap in a block of houses .

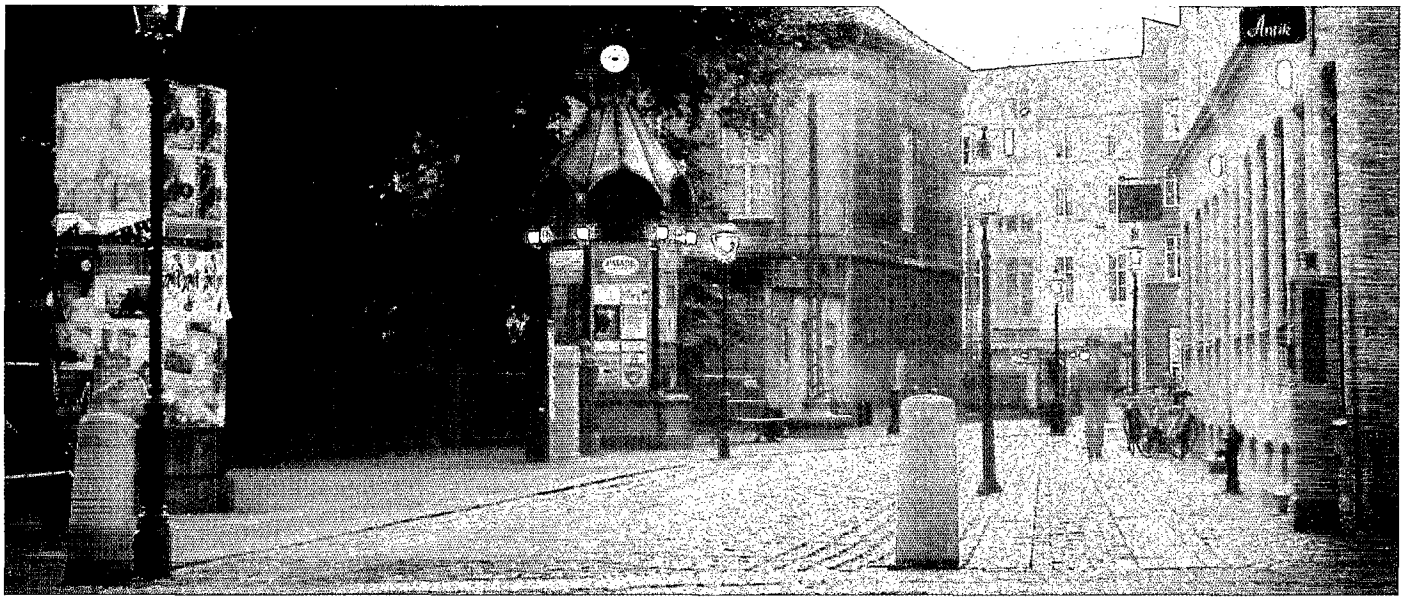


If one wants to divide a large space into smaller ones, hedgerows can be very suitable.

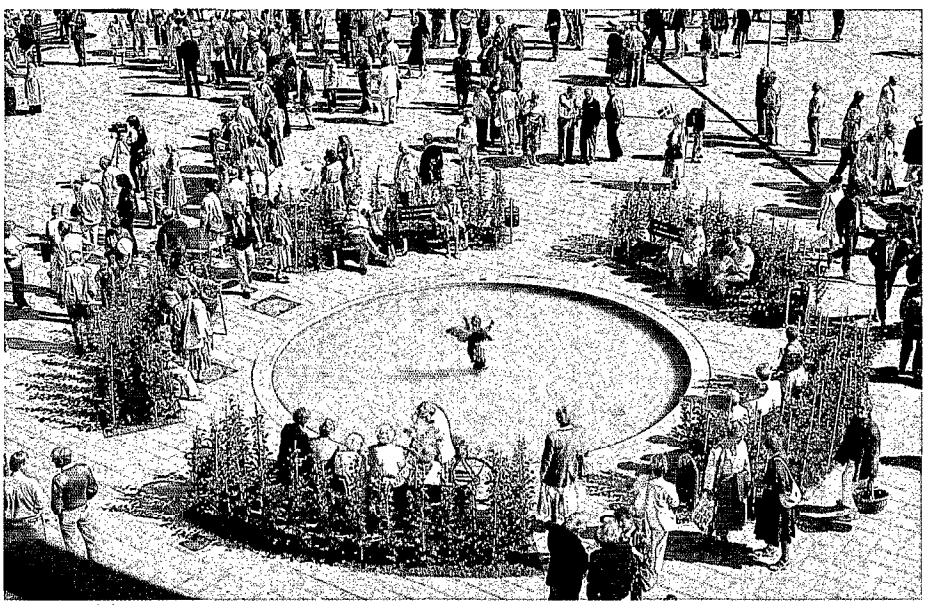


The flowers of the season can add a beautiful touch to the street scene.

Furniture and Fixtures



benches
tables
reclining furniture
litter boxes
bicycle racks
shelters
phone boxes
public conveniences
light kiosk buildings
playground equipment
posts
signs
parking meters/parkomats
bollards
advertising pillars
embellishments
mail boxes
dog toilets
flower arrangements

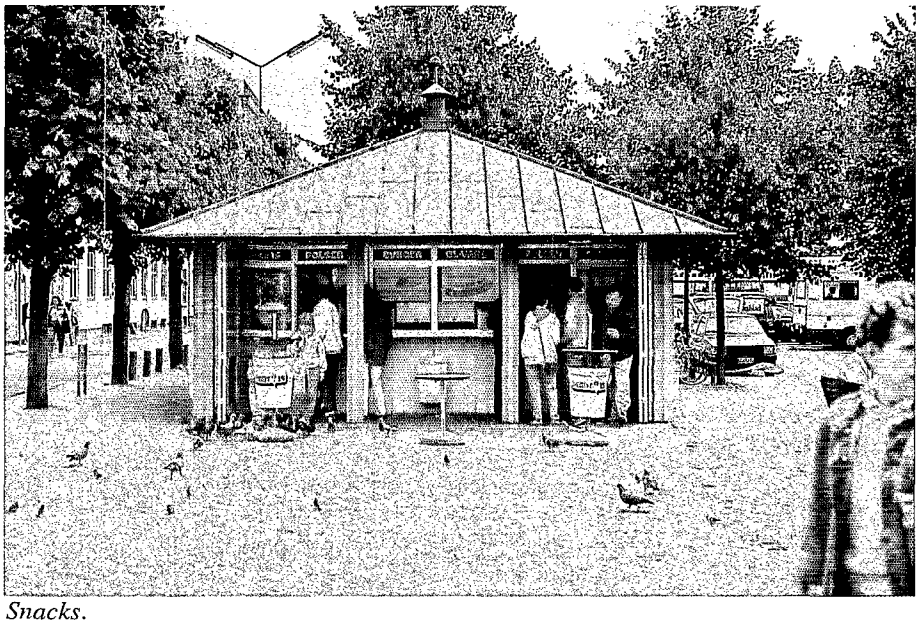


Rest and leisure.

Shelter.

Parking.

Communication.



Snacks.

The furniture and other equipment of the street scene should first and foremost meet the functional requirements. It must be appropriately designed, resistant to weather, wear, and vandalism, and preferably also acquire an attractive patina. In addition, equipment should be chosen whose form, materials, and colours blend harmoniously into the whole of a particular area, be it a street, a precinct, or an entire municipality.

New, individually developed designs may be adopted, or known ranges of equipment governed by an overall design.

Also with respect to the siting, the primary consideration should be the function of the given furniture. But the overall unity should be considered as well, both as regards the visual environment and the functional interdependence with other furniture.

The overall traffic geometry should be part of these considerations. For example, the siting of street furniture can help to define and demarcate the driving areas of a pedestrian zone and perhaps create the narrowings and staggerings which may be necessary to reduce the speed of cars in the area.

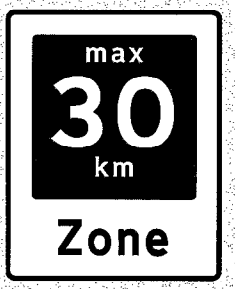
Information.

Signs and Marking

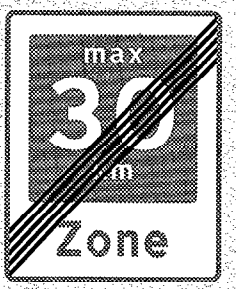
Road marking should be restricted to the required minimum both for aesthetic reasons and to limit the amount of information. In connection with a traffic calming project one should therefore always consider whether the same information can be conveyed through a sensible design of the traffic areas as via signs and marking.

Marking of the carriageway is required first and foremost on traffic roads. On local roads and in pedestrian zones it should be limited as much as possible.

Also as regards road signs the primary requirements of clarity and easy under-

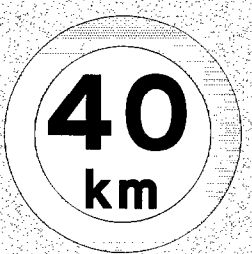


E53, area with speed reduction. Recommended max. speeds can be 20, 30, 40 or 45 km/h, and the carriageway should be designed to be inappropriate for significantly higher speeds than indicated.

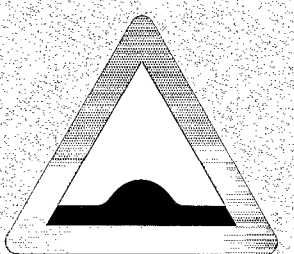


E54, end of area with speed reduction. The sign is used at exits from areas indicated by E53.

E55, built-up area. Maximum allowed speed 50 km/h.



C55, local speed limit 40 km/h. The sign is sited where a stretch of road is equipped with speed reducers allowing a bus to pass at 40 km/h.

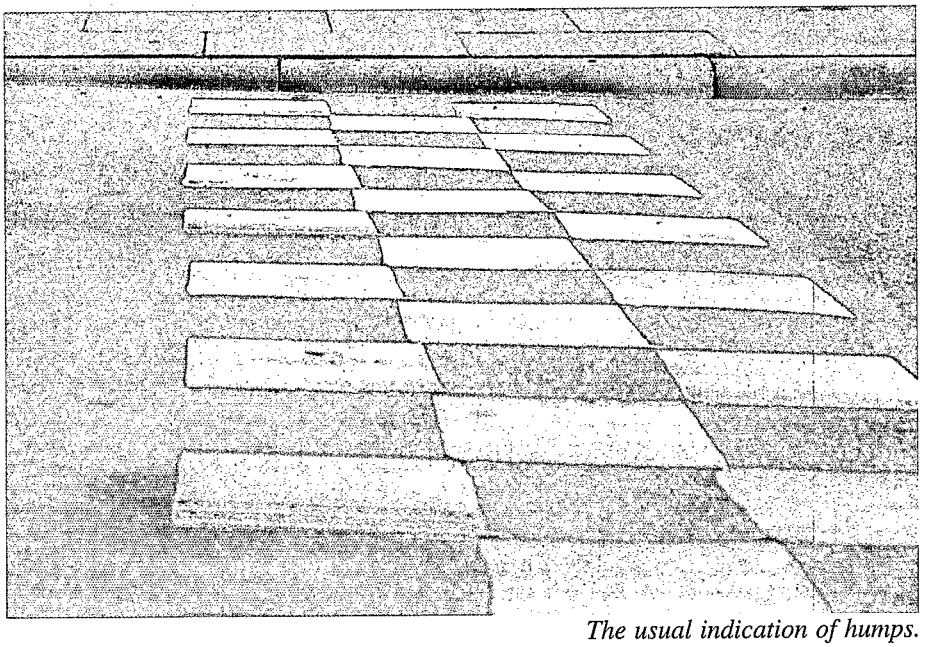


A36, hump. The sign is used as a warning of humps ahead.

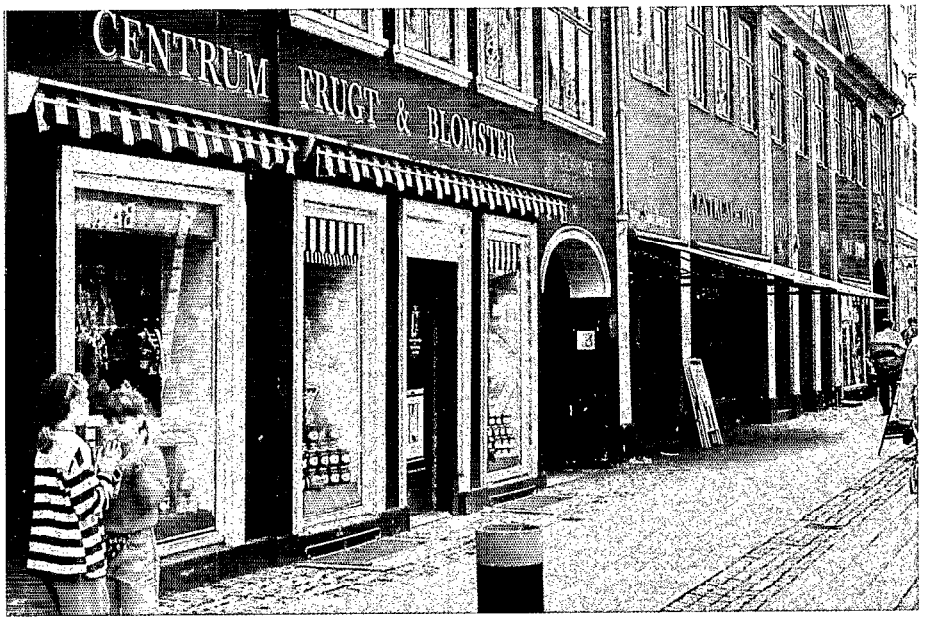
standing should be matched with sign sizes that agree with the dimensions of the street space and the road users going there. Among other things it should be considered whether in certain situations a zone marking would suffice rather than a marking of the whole stretch, for example to indicate parking restrictions.

Road name signs, signs for institutions, and other public informative signs should first and foremost be easily readable, and secondly be integrated in a common design regarding sign sizes, materials, colours, typography, and symbols.

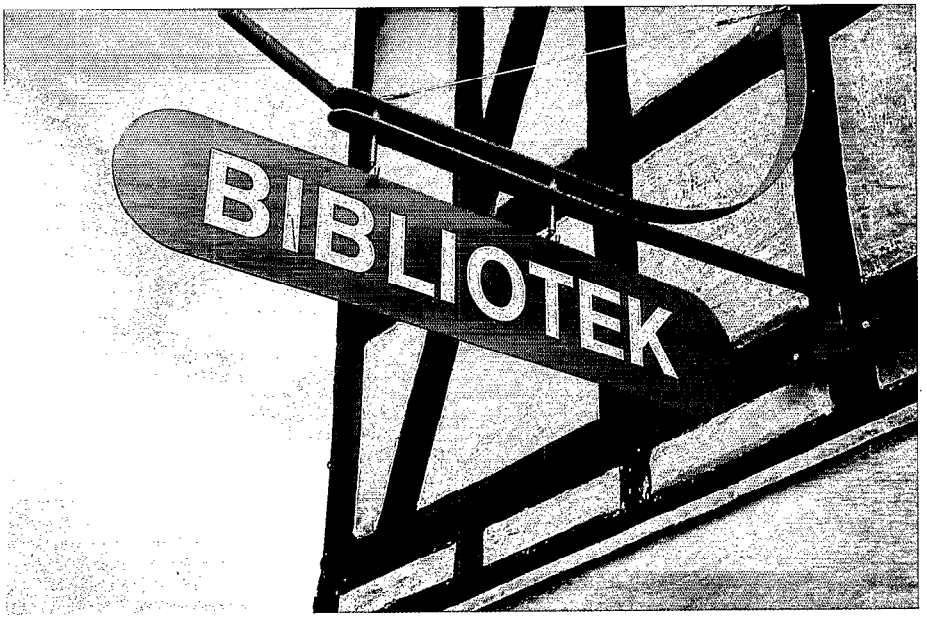
It can be considerably more difficult to integrate private signs in such overall design policies, but good examples exist which prove that splendid results can be achieved from a co-operation between municipalities and shopkeepers.



The usual indication of humps.



Shop signs that venerate history and the visual environment are becoming more and more common.



Public signs can contribute neatly to a harmonious urban environment.

Lighting

The primary function of lighting is to enable people to see at night, so that they can move safely and securely. Lighting should therefore illuminate other road users and the nature and scope of traffic-related arrangements. In addition, lighting can help to emphasize the alignment of a road, indicate intersections, etc.

But lighting devices are also visible during the day. Therefore they should be sited and formed with due regard both to their primary function and to the visual environment generally.

The choice of lighting means deciding on a variety of factors with respect both to the light as such and to the method of providing lighting.

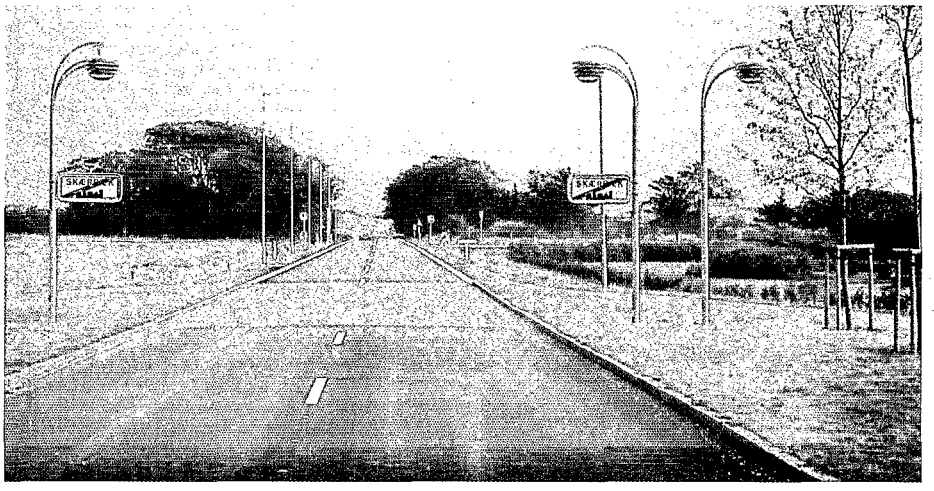
Decisions concerning the light itself should be made for the luminous flux, the intensity, the illuminance, and the luminance, and against this background the following must be chosen: lighting class, the nature and height of the illuminator, and the distance between illuminators.

Lighting should be utilized consciously, on a par with the many other technical and visual elements. Here the lamps - and at night the light - help to mark the gate at the transition between town and country.

Regarding the establishment of the lighting, choices must be made between different lamps, poles, and pylons.

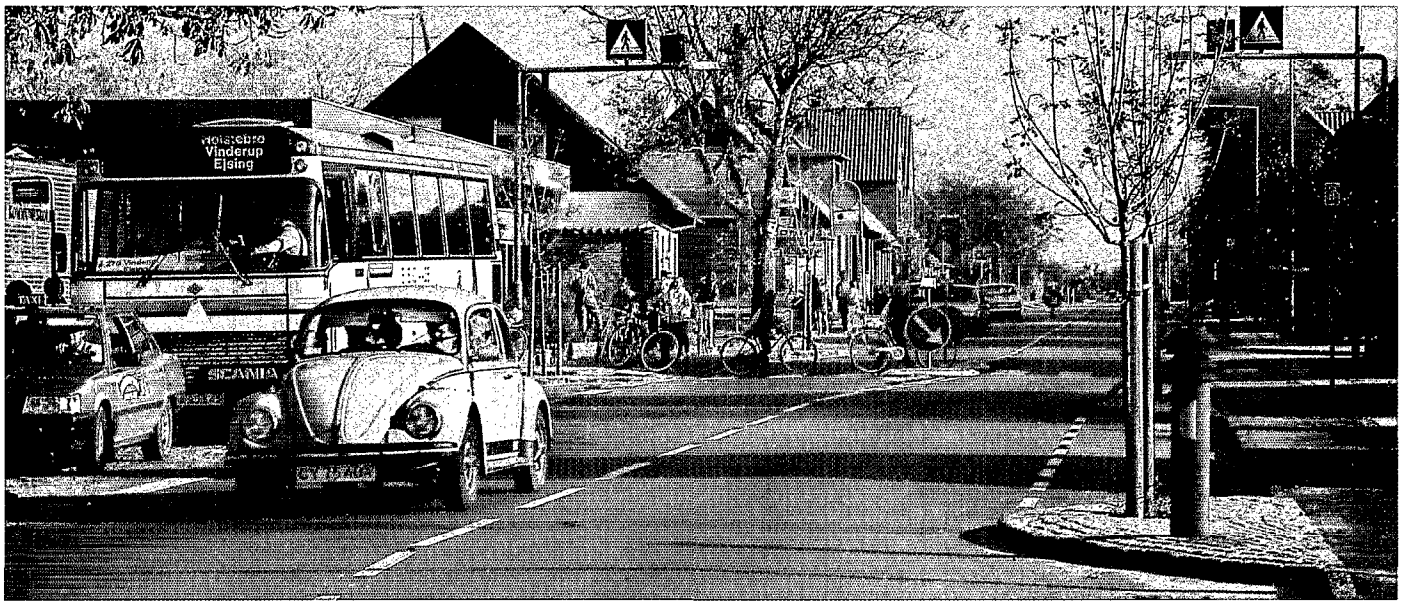
All these decisions must be made with due regard to road classes, speed classes, road user groups, the nature of the street space, local architectural characteristics - and the budget *(38)*

The speed reducer is illuminated and the lamp-post is part of the speed reducer.



7. Speed Reduction Techniques

Speed Reducers



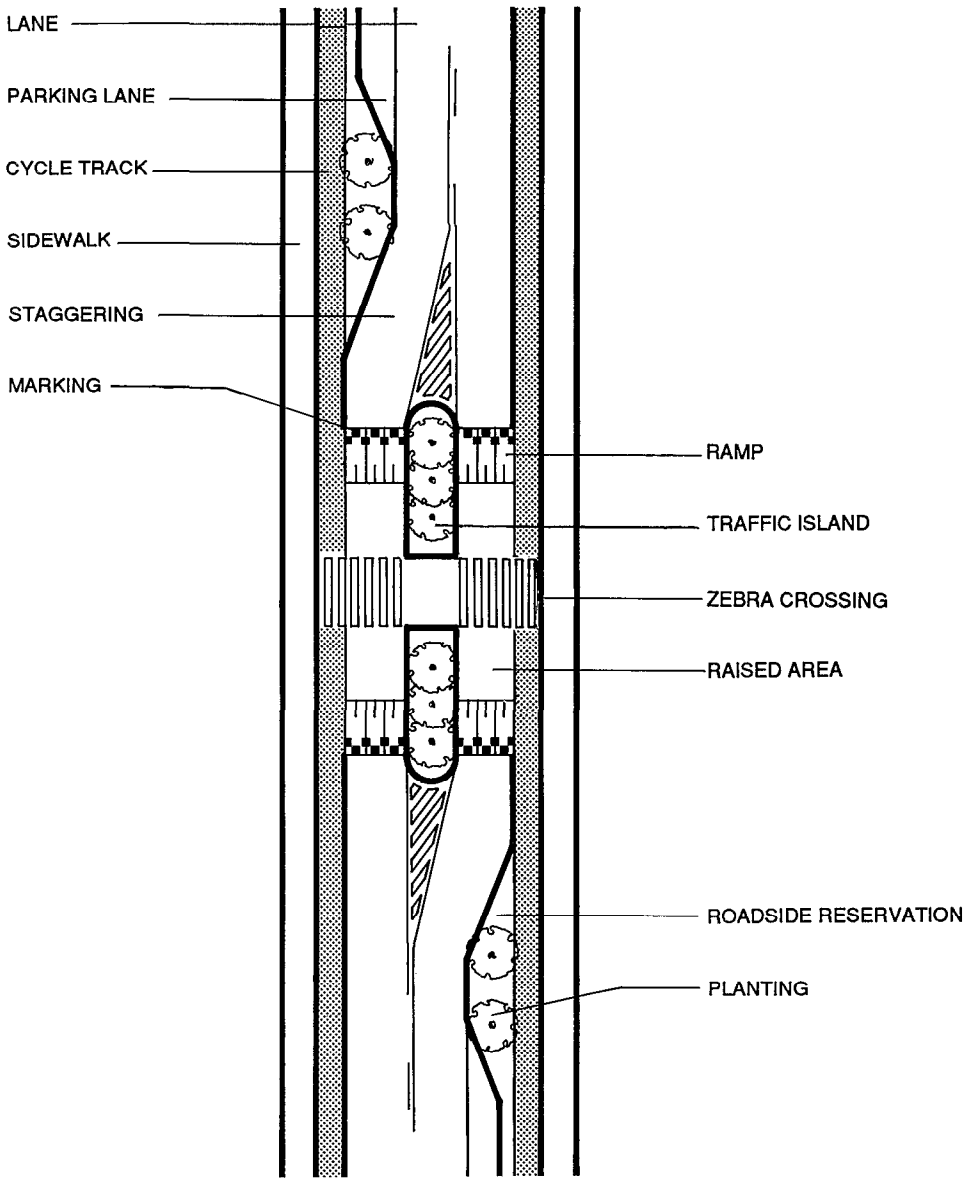
One of the most important objects of traffic calming is to reduce car speeds - and the variety of physical techniques used are referred to collectively as speed reducers.

The choice of which speed reducers to use in a given case depends first and foremost on the object to be achieved, and more specifically on the road class, desired speed, and traffic flow of the road in question.

This chapter devotes individual sections to descriptions of the main devices, i.e. pre-warnings, gates, humps, raised areas, narrowings, and staggerings. However, the main devices are often combined, which will appear both from the description and from the illustrations.

A detailed description of the use, siting, marking, and design of speed reducers can be found in Road Standards for Urban Traffic Areas, volume 0, Road Planning in Urban Areas, and in volume 7, Speed Reducers *(15, 16)*.

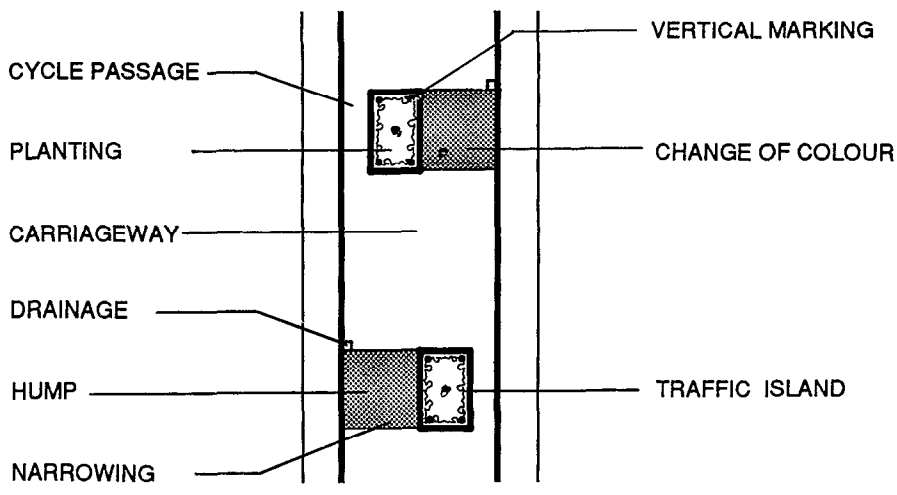
It is important that the instructions in the two volumes are followed, primarily to ensure that the actual car speeds after the traffic calming correspond with the desired speed.



Principle of a staggering with a raised area, with indication of constituent elements.

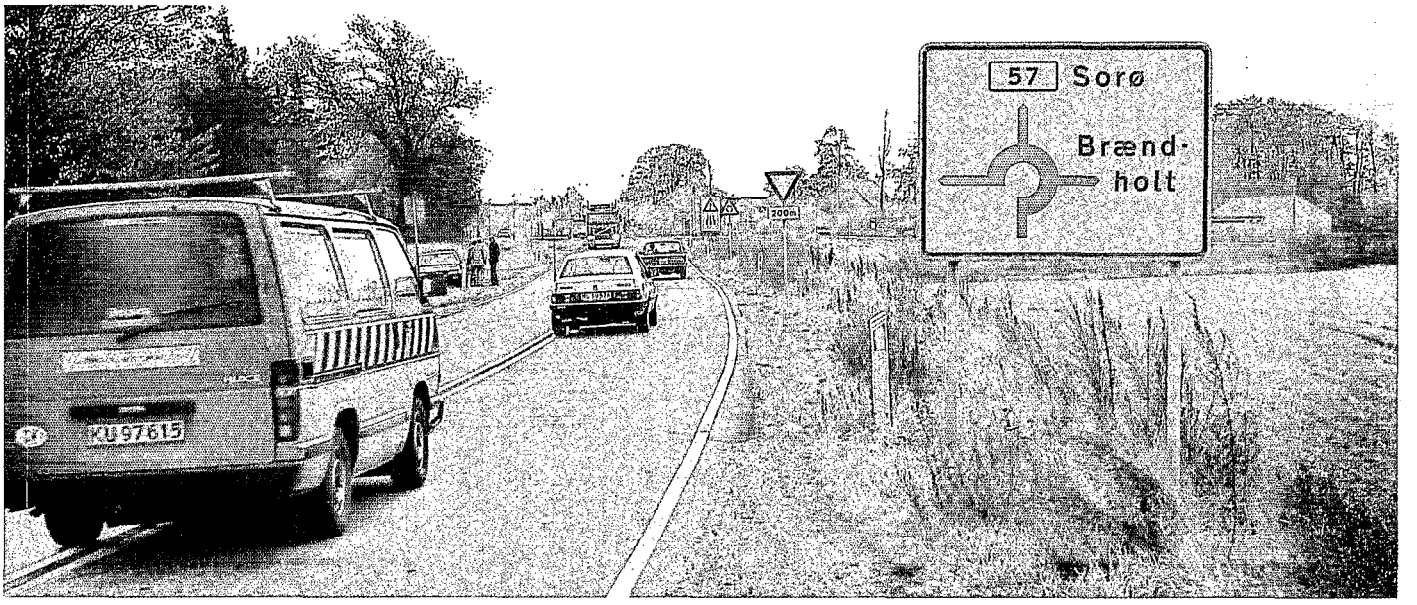
Applications of different types of speed reducers.

Main Type	Road Class		Desired Speed (km/h)			Annual Day Traffic (ADT)	
	Traffic Road	Local Road	≥60	50	≤40	>3000	≤3000
1 Pre-warnings	x	x	x	x	x	x	x
2 Gates	x	x	x	x	x	x	x
3 2-lane raised areas	x	x		x	x	x	x
4 2-lane humps	x	x		x	x	x	x
5 Staggerings	x	x	x	x	x	x	x
6 Staggerings with raised area	x	x		x	x	x	x
7 2-lane narrowings from road centre	x	x		x	x	x	x
8 2-lane narrowings from roadside	x	x		x	x	x	x
9 Narrowings to 1 lane	(x)	x			x		x
10 Narrowings to 1 lane with raised area	(x)	x			x		x
11 Narrowings to 1 lane with humps	(x)	x			x		x
12 Staggerings with narrowing to 1 lane	(x)	x			x		x
13 Staggerings with narrowing to 1 lane and raised area	(x)	x			x		x
14 Staggerings with narrowing to 1 lane and humps	(x)	x			x		x
(x): To be used only in special cases							



Principle of a staggering with narrowing to 1 lane and humps, with indication of constituent elements.

Pre-warnings

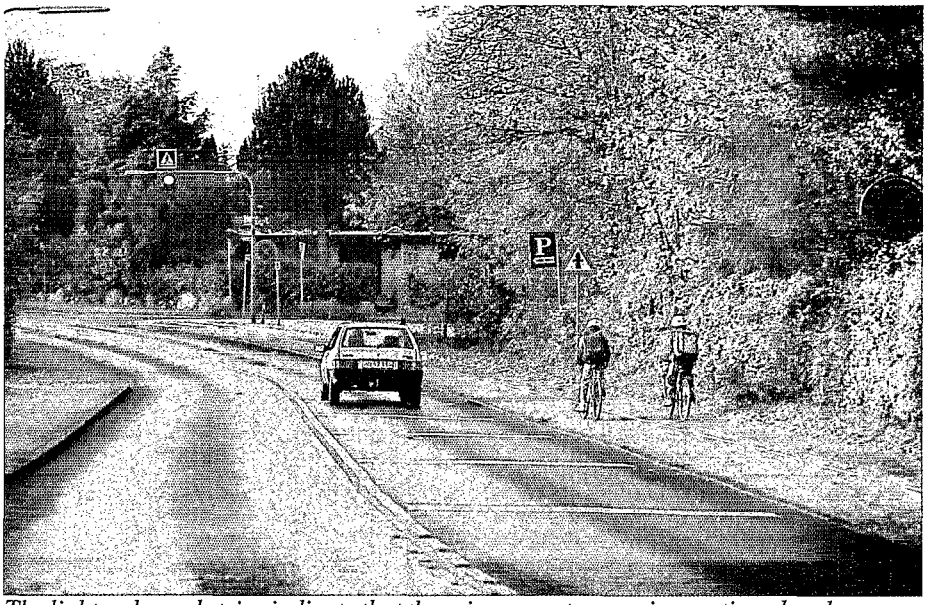


A pre-warning must ensure that the subsequent speed reducing measures, intersections etc. do not appear as a surprise to drivers. A pre-warning should not be physically speed reducing in itself, but may have as one of its desired effects to make car drivers ease the pressure on the accelerator and slow down.

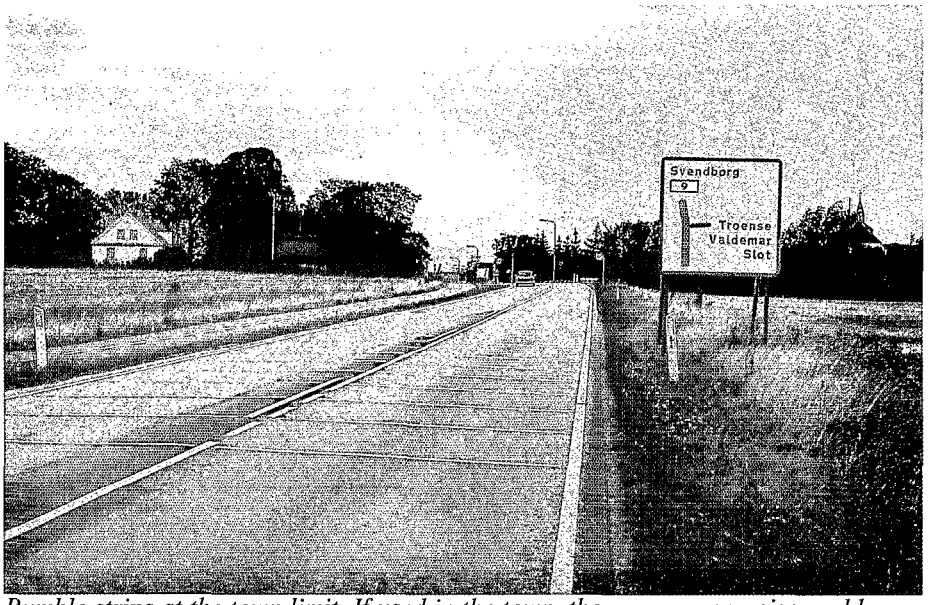
In its traditional form a pre-warning is a road sign indicating the nature of the stretch of road ahead and the local speed limit or recommended speed for the stretch. But the pre-warning can also be - or can be supplemented by - vegetation, lighting, "flickering", rumble strips, etc.

The flickering effect can be created by means of alternating light and shadows, for example by a row of trees along the road or by painted contrasting stripes across the road.

Rumble strips can be established in the form of a series of raised thermoplastic or paving strips laid across the lane. The sound and the vibration caused by a car's passage over the rumble field will sharpen the driver's attention and, most often, make him reduce the speed. Normally, rumble fields should not be used close to dwellings as they can cause considerable noise problems in the surroundings *(32)*.



The light-coloured strips indicate that there is reason to exercise caution ahead.



Rumble strips at the town limit. If used in the town, they may cause noise problems.

Gates

In the context of traffic calming gates are used to indicate the transition from one traffic environment to another, to another suitable traffic behaviour and, primarily, to another speed.

They can be used at different levels: to emphasize the transition between country and town, or to indicate the limit of a particular town area, e.g. the town centre. Or on local roads to indicate the entrance to a local traffic area from the traffic road system.

Through centuries the border between country and town was demarcated by town gates, which were even closed at night. In a few places these old town gates have survived on the dividing line between what is now the medieval town centre and newer urban areas.

Today the border between town and country is less distinct and this is one of the reasons why the urban-zone mandatory speed sign is often ignored by drivers. The transition can be emphasized by a gate at the town border.

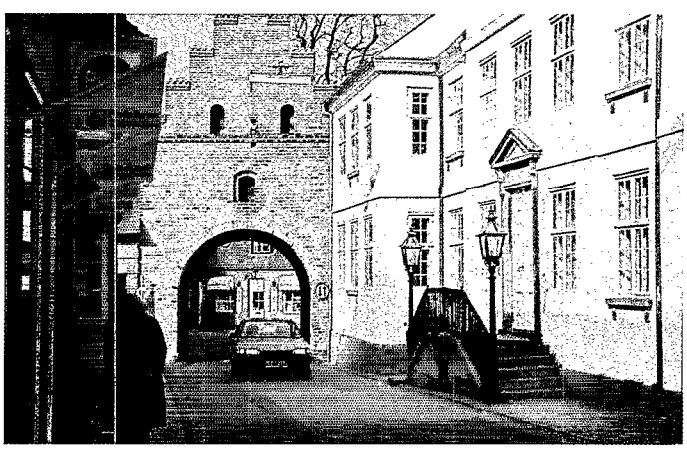
Such gates may, as in previous times, take the form of actual building structures. But they can also be established by means of plantings, lighting, etc.

A gate should help to underscore the identity of the town or town area through the architectural approach, materials, plant species, etc.

Different traffic management techniques between town and country should begin at the gate. If there are cycle tracks through the town they should start here, and so should any reduction in the width of the carriageway.

At the entrance to a local traffic area, where the actual gate is often constituted by plantings, humps can be used as a supplement, or narrowing of the carriageway from 2 lanes to 1 etc., and one might give the gate some of the same characteristics as speed reducers within the area.

The speed reducing effect of gates depends on their design and on their context. The effect is greatest if they are given a distinctive design, if there are both visual elements and speed reducing techniques in them, and if they are combined with speed reducers on the stretch of road or in the area to which they demarcate the border.



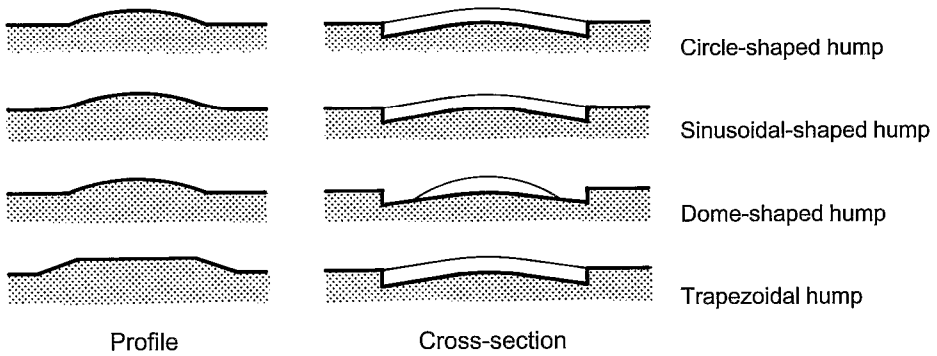
A few of our ancient town gates have survived.

The gate indicates that a path joins a road.

Humps

A hump is the speed reducing measure which best combines effective, physical speed reduction with a proper traffic flow.

These speed reducers are therefore widely used. They can be utilized on both traffic roads and local roads, and both on stretches of road, in intersections, and on specific spots of the road system.

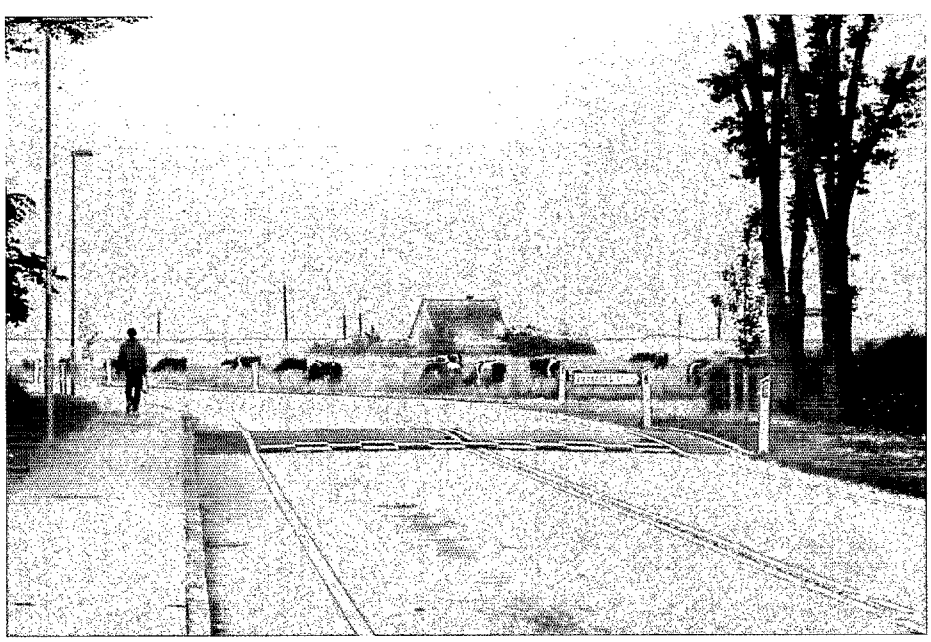


Humps can be designed to fit speeds of up to 50 km/h, and through the detail design a direct interrelation can be established between the planned, desired speed and the actual, resulting car speeds.

This requires meticulous design in compliance with the instructions of the "Urban Traffic Areas". The effect will be that cars pass the humps at speeds that are, on average, a little lower than the desired speed, which will feel slightly uncomfortable. Passage at speeds that significantly exceed the desired speed will feel very uncomfortable.

Depending on the purpose, the siting, and the regard to the overall visual impression, humps can be designed as circular, sinusoidal, dome-shaped, or trapezoidal humps.

Sinusoidal humps are circular humps, where the transition from the flat surface to the cylinder surface is rounded. They are more comfortable to cross for cyclists, but are difficult to design correctly.



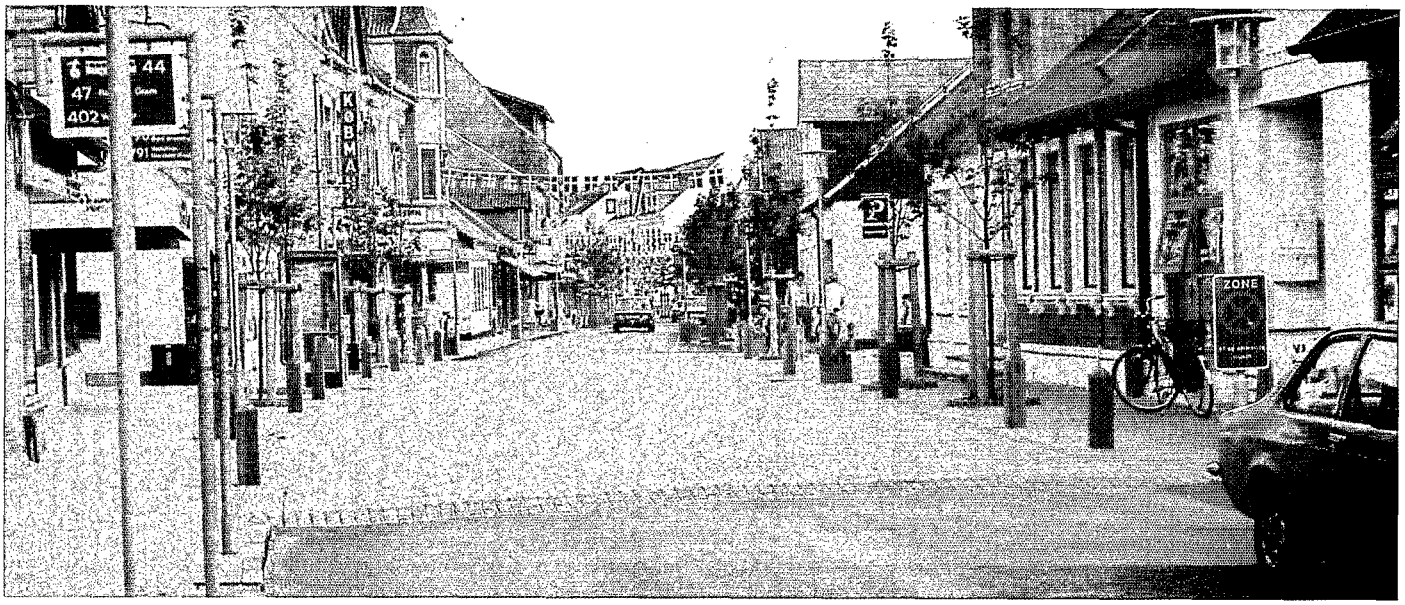
Circular humps can be designed for any speed between 20 and 50 km/h and cause an acceptable discomfort if crossed at the indicated speed. Discomfort for cyclists is moderate.

Dome-shaped humps can be utilized on stretches and in intersections. On stretches they are comfortable for cyclists and facilitate drainage. In intersections they may sometimes be mistaken for mini-roundabouts.

Trapezoidal humps can be used with a good architectural effect for example in connection with pedestrian crossings or squares. If designed correctly, the discomfort is moderate for cars, whereas lorries and buses must pass very slowly. According to the Road Marking Order here should be chess board pattern.

Combi-humps, designed as a circular hump using different radii corresponding to different track widths, permit cars and buses to pass at the desired speed and with the same comfort.

Raised areas

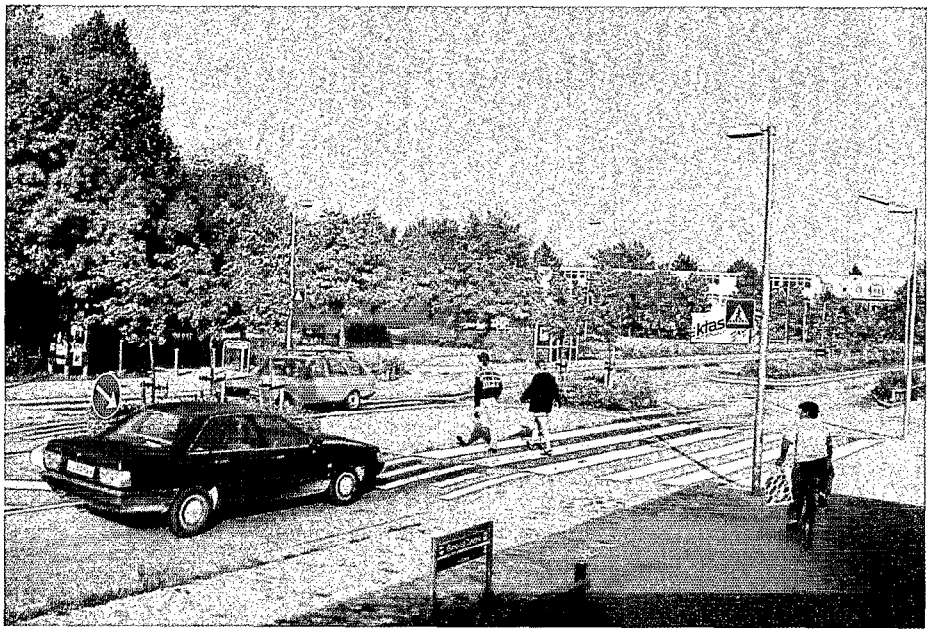


In principle, a raised carriageway is shaped as a trapezoidal hump. However, the actual flat surface is longer, typically 10 m or more, so that even large vehicles have all wheels on the raised area simultaneously.

Like humps, raised areas can be utilized for speeds up to 50 km/h on both traffic roads and local roads, and the speed reducing effect is very similar to that of trapezoidal humps.

The raised carriageways, however, have some very special uses: at points of traffic intersections where the carriageway is raised above the normal level, in a whole road intersection, or in and about an intersection of a road and a path. And also on squares and open spaces where the raised carriageway helps to indicate that special attention should be paid to the light road users.

This square, where driving is permitted, is a raised area.



The pedestrian crossing is sited on a raised area. The ramp to the area shows the car drivers that they must lower the speed and be watchful. According to the Road Marking Order this ramp should be marked with a chess board pattern.

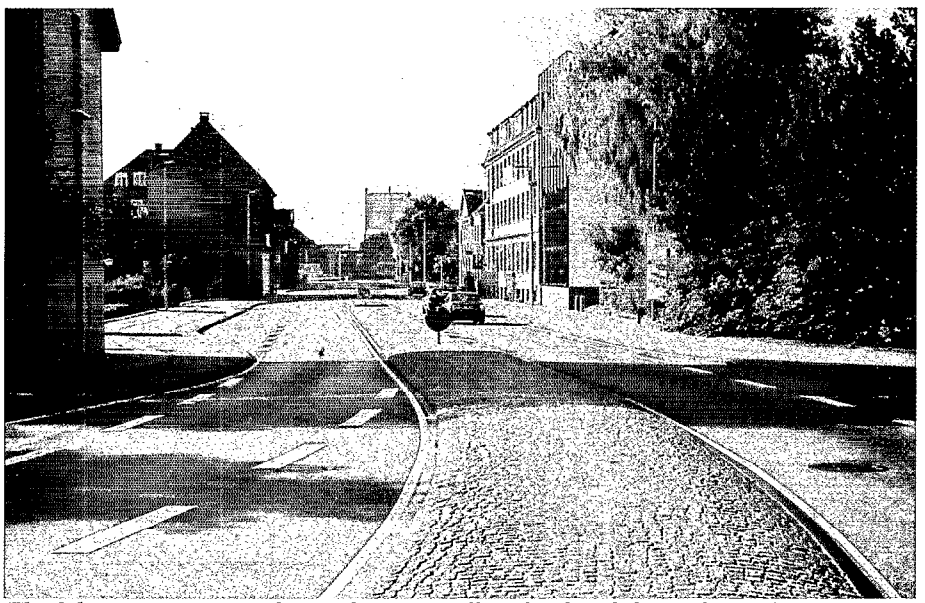
Narrowings

The narrowing of a 2-lane carriageway from normal width to two narrower lanes can take place from the centre line (by establishing a traffic island) or from the side of the road (by the establishment of roadside reservations etc.). Such narrowings can be used for speeds of 50 km/h or less and have only a moderate speed reducing effect.

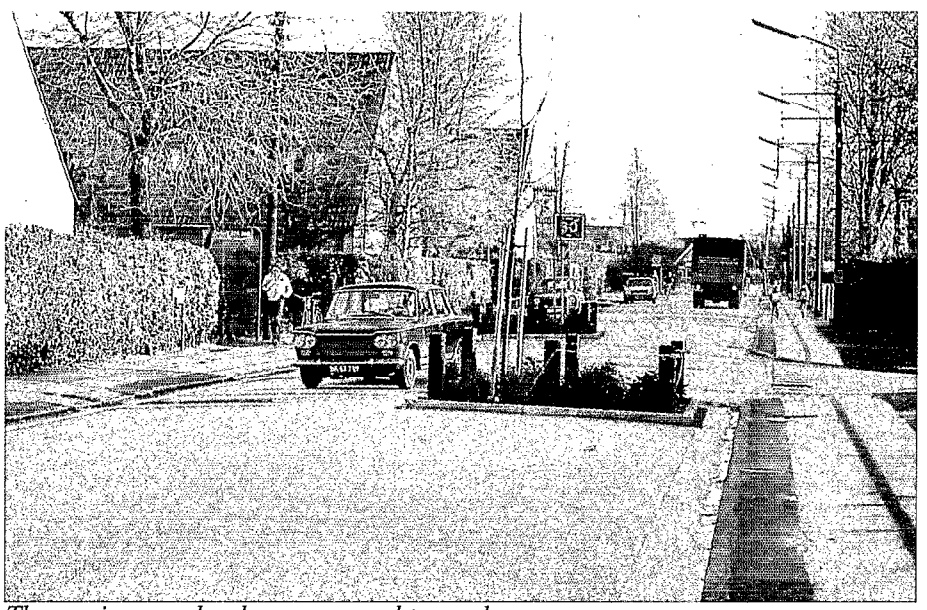
Where planners choose to narrow the carriageway in either of these ways it is therefore often connected with a wish to provide space for traffic islands, roadside reservations, parking bays, plantings and/or cycle paths within a restricted area.

Narrowing to one lane, where oncoming road-users must give way to each other, should only be used for speeds of 40 km/h or less. Such narrowings also have only a moderate speed reducing effect which to a large extent depends on the number of oncoming road users.

In addition to the speed reduction, however, such narrowings also provide the opportunity - via plantings - of dividing a stretch of road into visually acceptable and generally more attractive spaces.

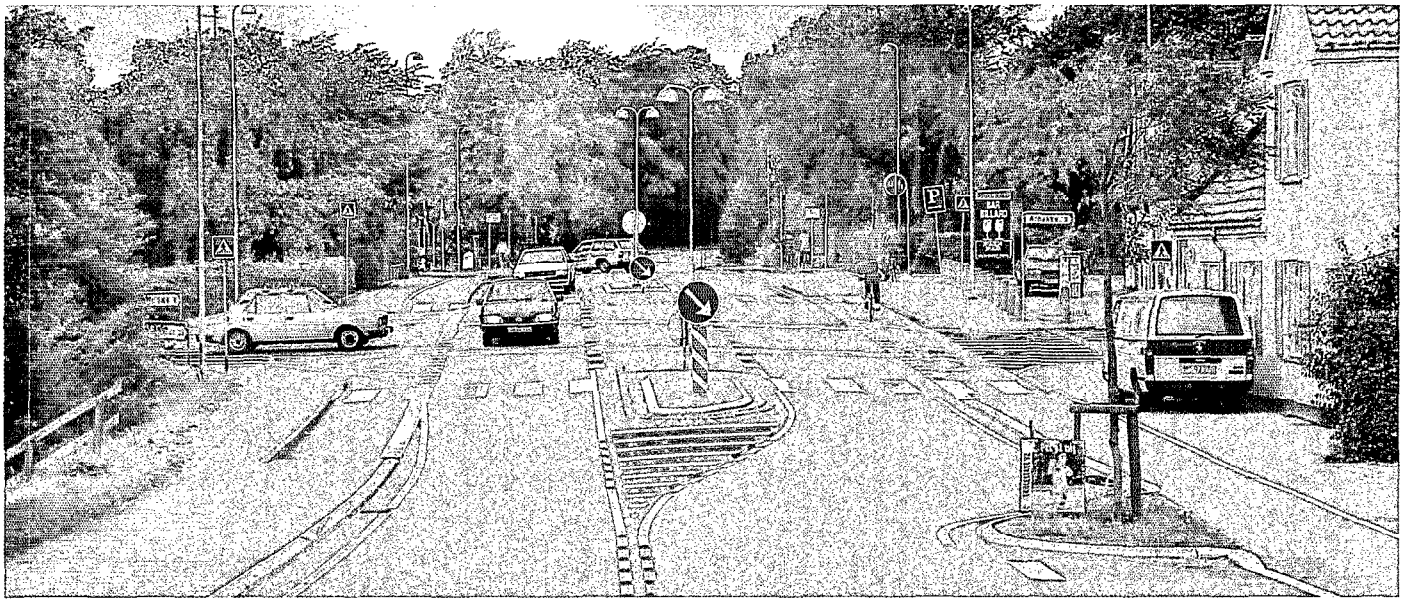


The 2 lanes are narrow due to the new traffic island and the cycle tracks.



The carriageway has been narrowed to one lane.

Staggerings

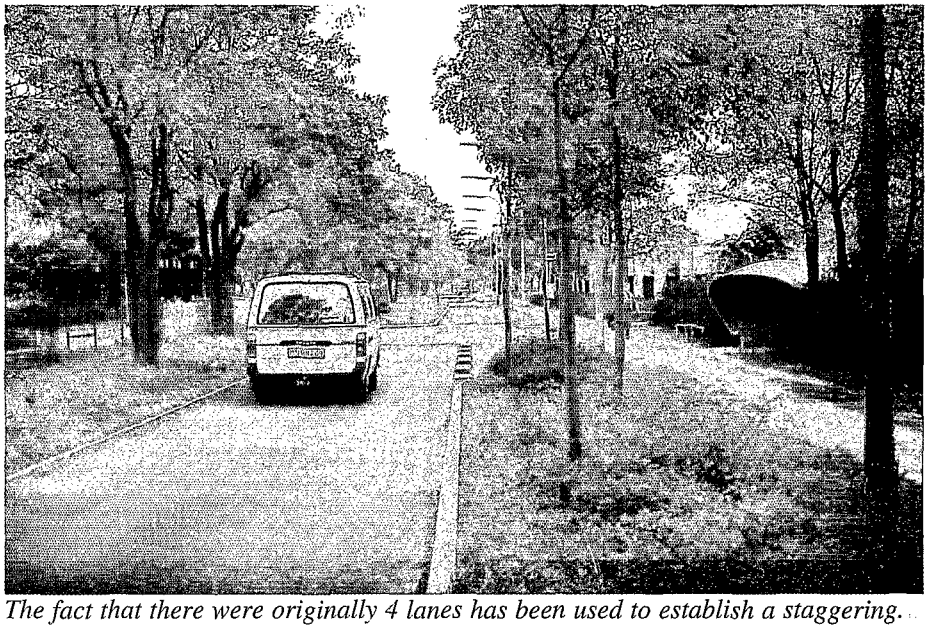


Staggerings can be used on roads with speeds of 60 km/h and less. They have a fair speed reducing effect, but it is more difficult than with humps to create a direct interdependence between the physical design and compliance with desired car speeds.

This is caused by the fact that the staggerings must not be too pronounced if lorries and buses are to pass safely. On the other hand this means that cars can pass at a higher speed than desired.

To reduce car speeds it may therefore be necessary to supplement staggerings with measures which enhance the drivers' impression of the change of direction, such as plantings or another road surface. If a staggering is to reduce speed effectively, it should preferably look like a road closure to the drivers approaching it *(39)*.

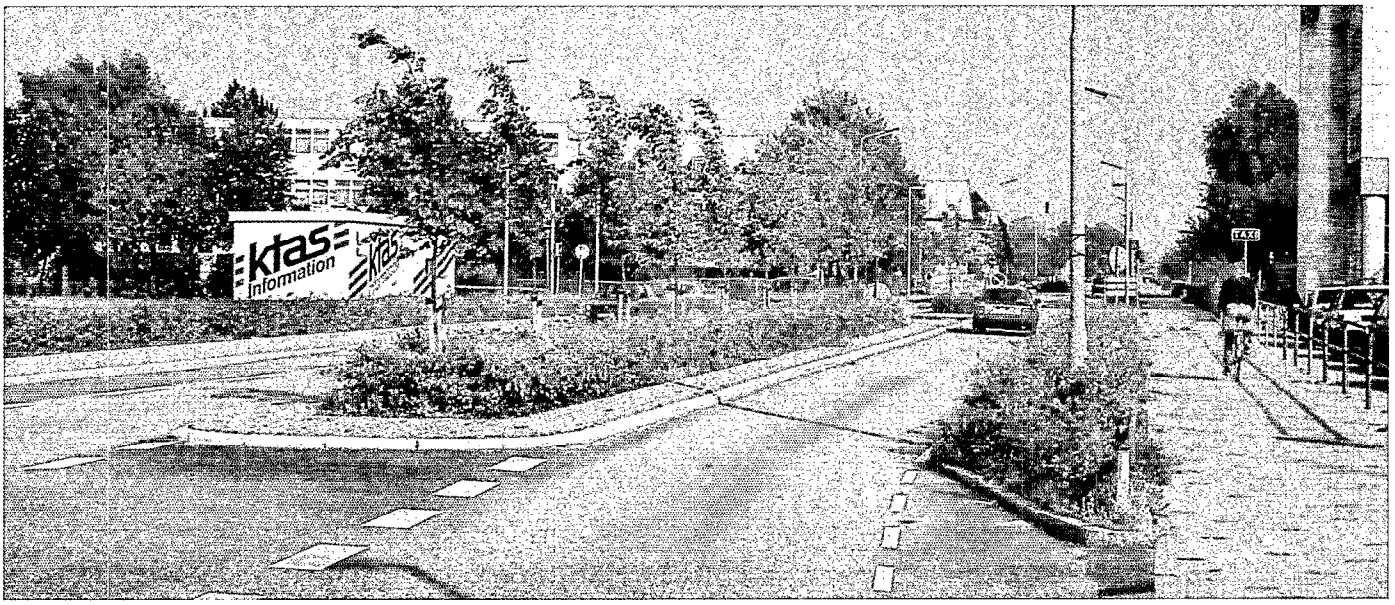
Staggerings disrupt a road's traditional alignment. Where there is a characteristic interdependence between the street space and the form of the buildings, it is therefore important that the establishment and design of staggerings are carefully considered.



The fact that there were originally 4 lanes has been used to establish a staggering.

The kerb stone is white and bevelled.

Islands and Reservations

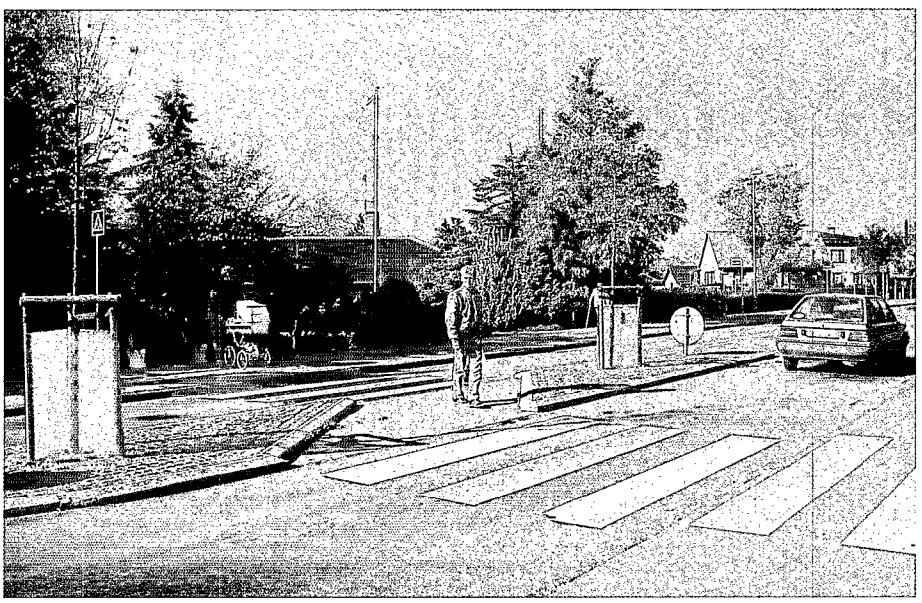


Central traffic islands, roadside reservations, and dividing reservations may - with stone-set or paving slab surfaces, or planted with rows of trees, hedges, bushes, or ground cover - serve for a number of purposes in connection with traffic calming schemes.

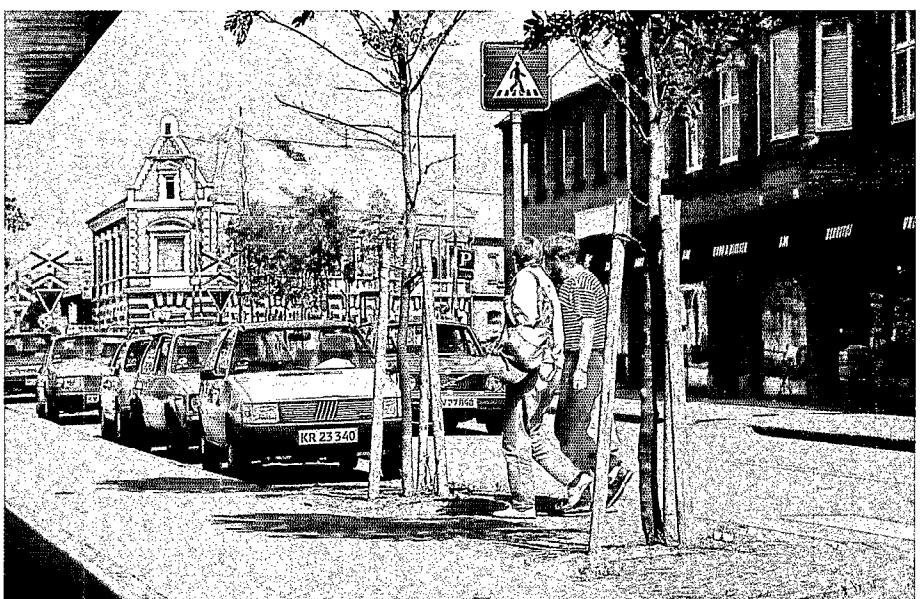
Central traffic islands separate two-way traffic, prevent overtaking, and can also prevent unwanted left-turns. They permit pedestrians to cross the road in two stages so that they only have to concentrate on one traffic direction at a time. They can also, if planted with trees and bushes, make up green walls in the street space and so contribute to an improved visual environment.

Roadside reservations or refuges can be a direct extension of the sidewalk area and thus help pedestrians to cross a street. They can also serve as "screening-offs" for parking bays. And like other islands or reservations they can be used for plantings.

Dividing reservations can be utilized to reduce the width of the carriageway and to shield cycle tracks or sidewalks, resulting in improved security for light road users.

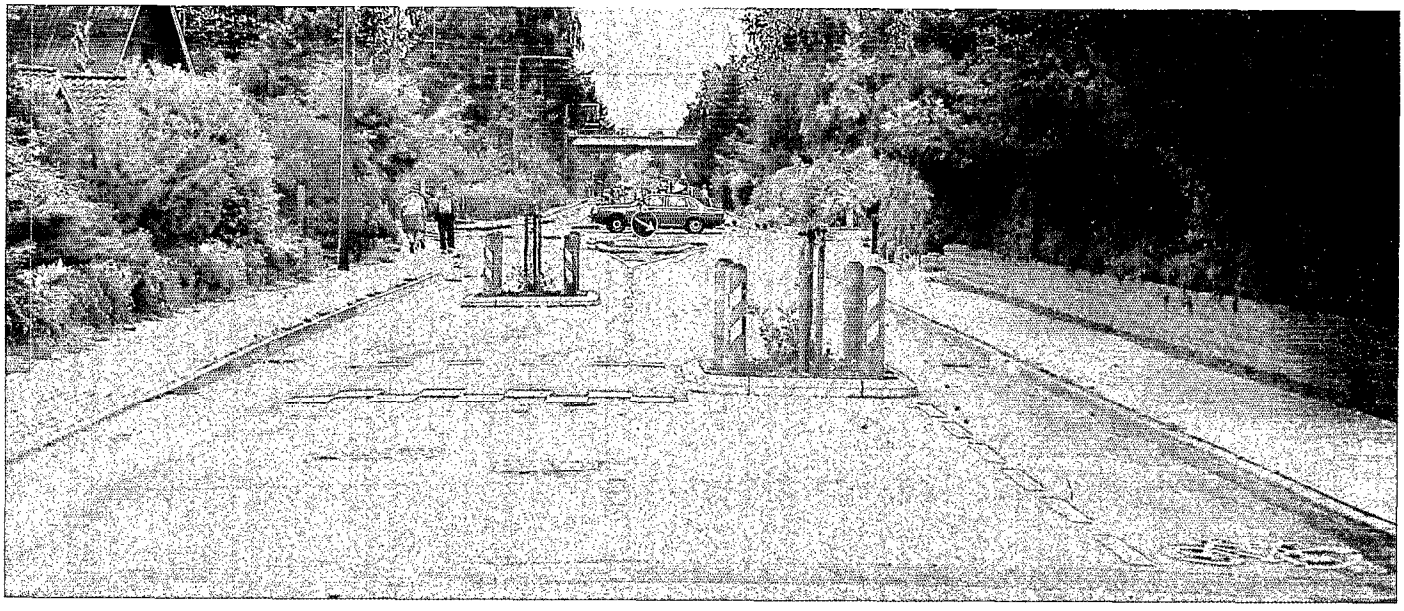


The central traffic island reduces car speeds and facilitates pedestrians' road crossing.



The roadside reservation moderates car speeds, shortens road crossing for pedestrians, provides space for plantings, and screens off the parking

Combinations of the Individual Techniques



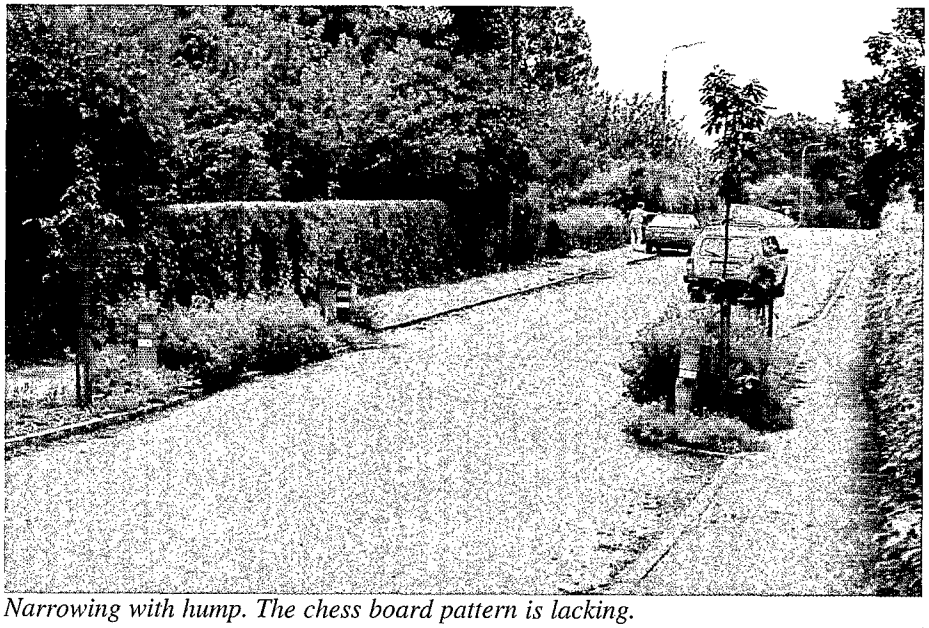
In order to achieve the correct speed reducing effect it will very often be expedient to use combinations of the individual elements referred to in the preceding sections.

Combinations may be

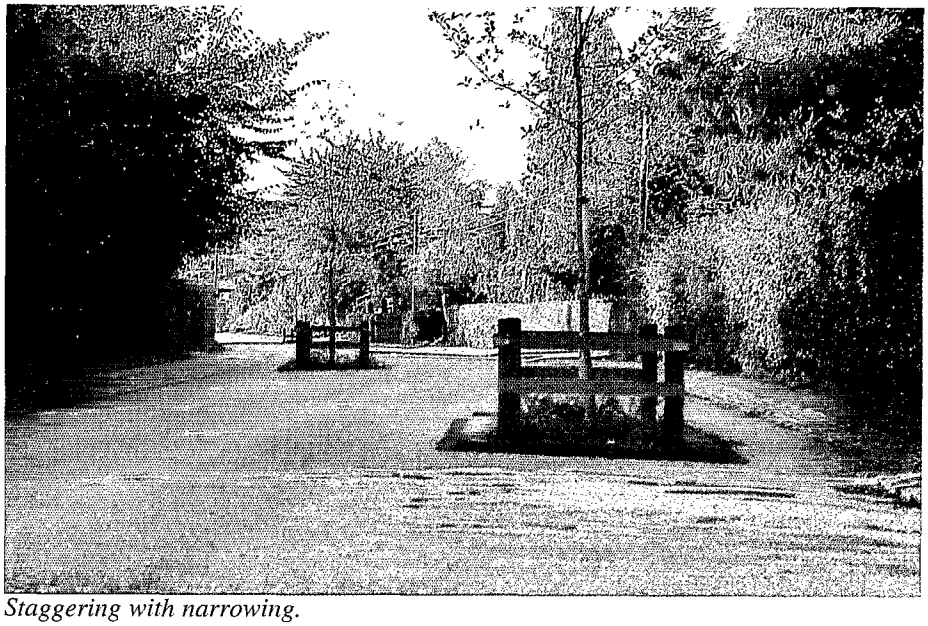
- narrowings to 1 lane with raised area
- narrowings to 1 lane with humps
- staggerings with raised area
- staggerings with narrowing to 1 lane
- staggerings with narrowing to 1 lane and raised area
- staggerings with narrowing to 1 lane and humps

Traffic islands or reservations also are often part of such solutions.

When considering at which upper speed limit such combined solutions can be used, the main rule is that the lowest upper limit among the individual elements will govern the other elements.

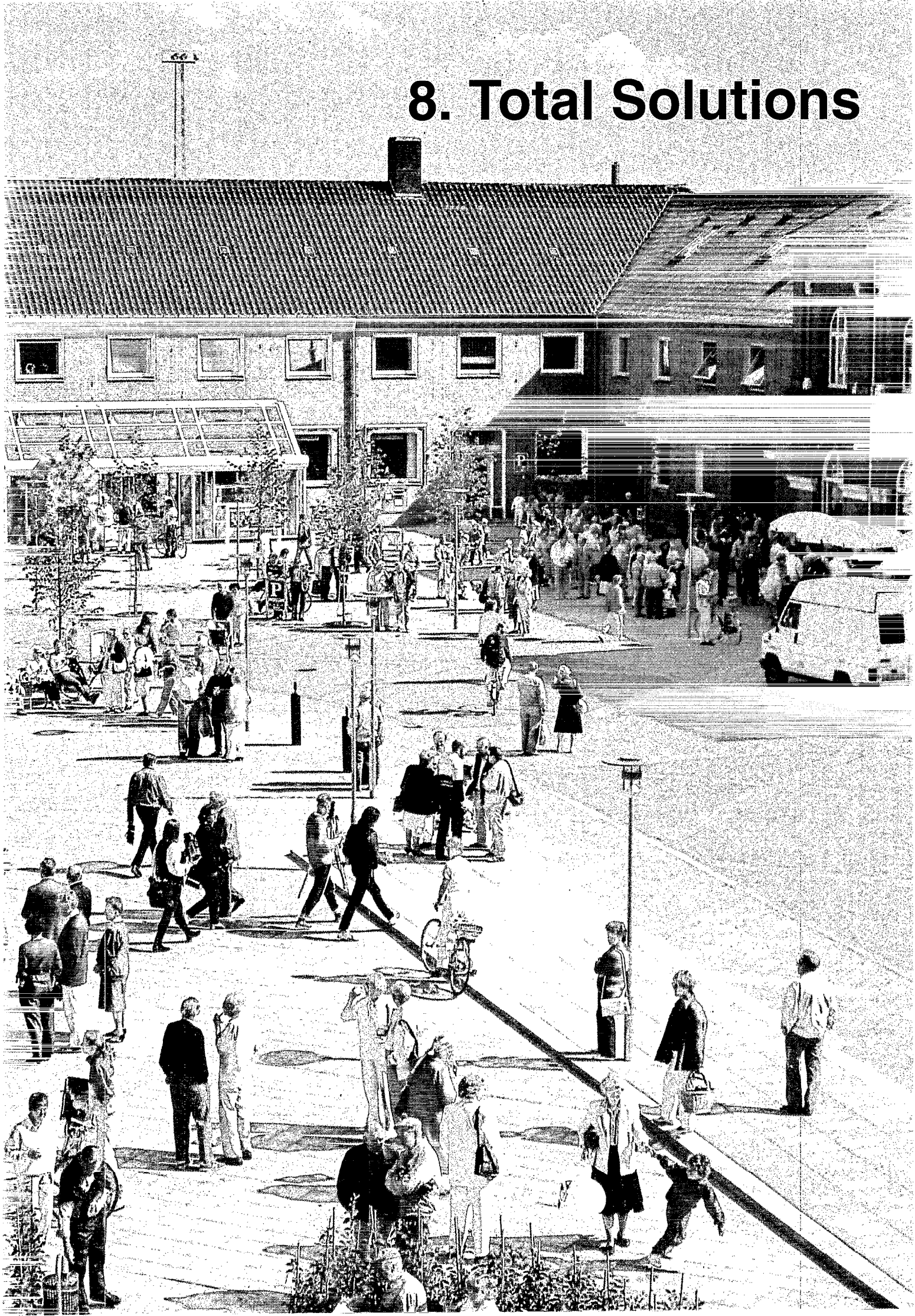


Narrowing with hump. The chess board pattern is lacking.

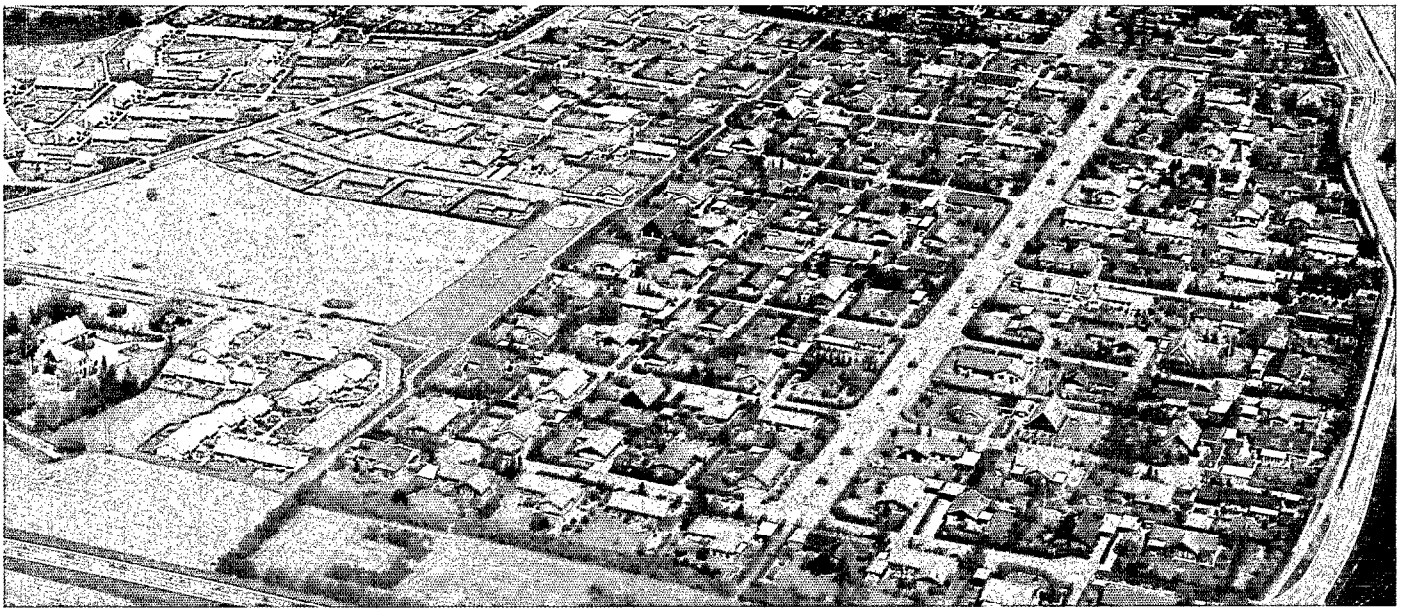


Staggering with narrowing.

8. Total Solutions



Precincts



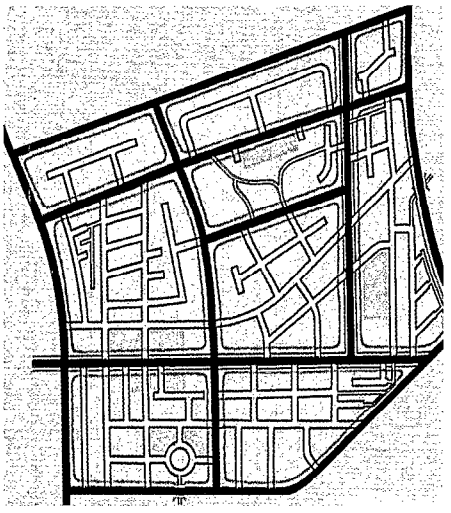
Any traffic calming effort should first and foremost begin with the preparation of a traffic calming plan for the whole of the town area in question. The plan should include a functional classification and a speed classification of the road network, a description of the light road users' main routes, identification of points of intersection, etc. *(15)*.

In this way it can be ensured that the individual conversions, which will often take place over a period of years, will always be part of a functional whole.

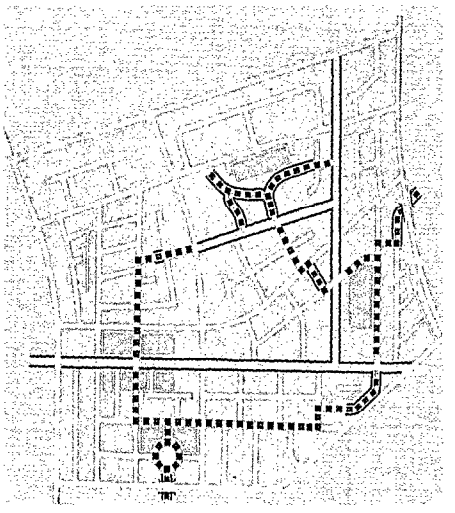
But also the actual design of the individual stretches of road, of the speed reducing measures, etc., should be carried out with regard to the overall unity.

It is important, from the point of view of urban architecture, that when a town or a town precinct with a shared identity is changed, this identity should be preserved or even enhanced. And on the other hand it may be desirable to try to establish an architectural unity in a townscape which may, at the outset, be somewhat fuzzy and incoherent.

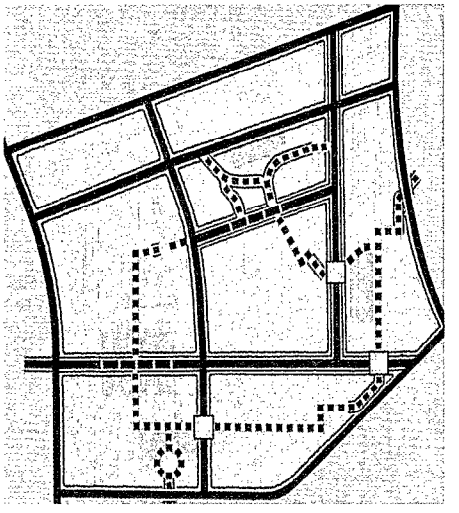
A certain consistency is also important as regards the technical contents of the traffic calming. The speed reducing elements should be of the same kinds so that drivers are not constantly being surprised by new designs, which would result in inappropriate behaviour. For example, the first speed reducer that a driver encounters on his way into a local traffic area should preferably be designed so as to give the driver a hint about the nature of the other measures in the area *(16)*.



The classified road network.

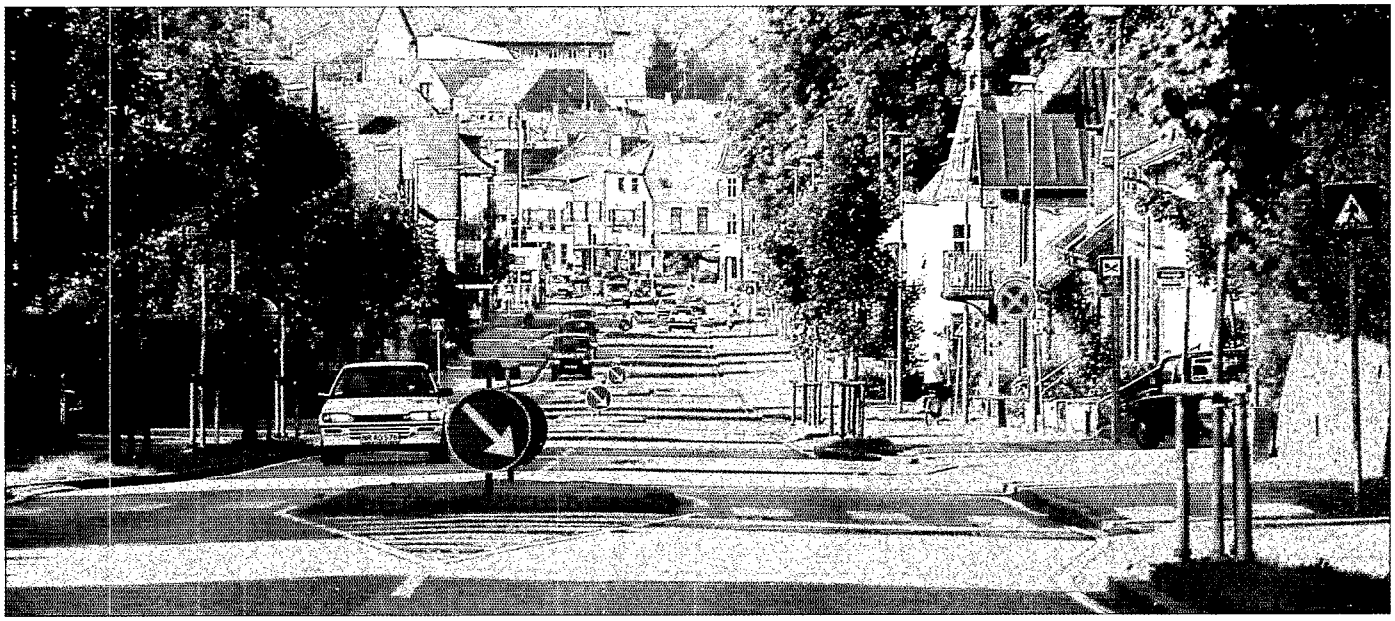


The light road users' main traffic network.



Intersections and crossing points.

Stretches of Road



Naturally, the concern for the urban architectural unity and for the consistency of the technical content is equally important for the individual stretch of road as for the entire town area. In addition, the wish that drivers observe the desired speed should be made fundamental to the total solution.

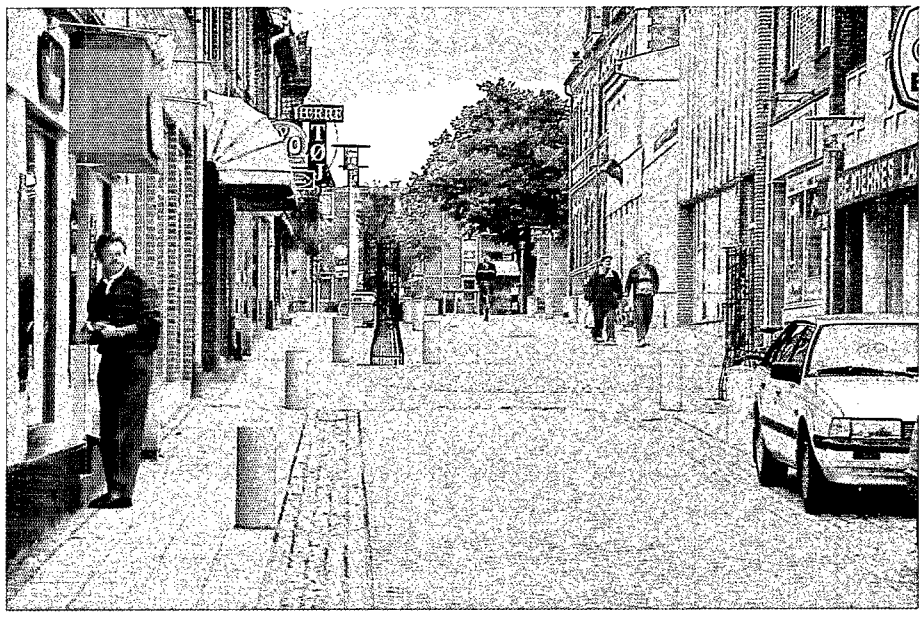
If the individual speed reducers, especially humps, of a stretch of road have been designed in accordance with the desired speed, experience shows that the cars will pass them at speeds that are, on average, slightly lower.

Between speed reducers most drivers will speed up, the more so the longer the distance between the speed reducers. Firstly, this will be in opposition to the regard to safety and security which led to the determination of the desired speed for the stretch. Secondly, in order to minimize such environmental impacts as noise and air pollution it is important that the speed profile achieved is as even as possible, with only few slight accelerations and decelerations *(40)*.

The desire to provide a sufficient number of speed reducers with a suitable, physical speed reduction and the concern for a satisfactory, urban architectural solution will often go hand in hand. And if, on the basis of such overall considerations, a scheme is made in which the road users experience the traffic calming as a consistent solution both from the point of view of traffic and urban architecture, one is very close to the goal: traffic management by design.

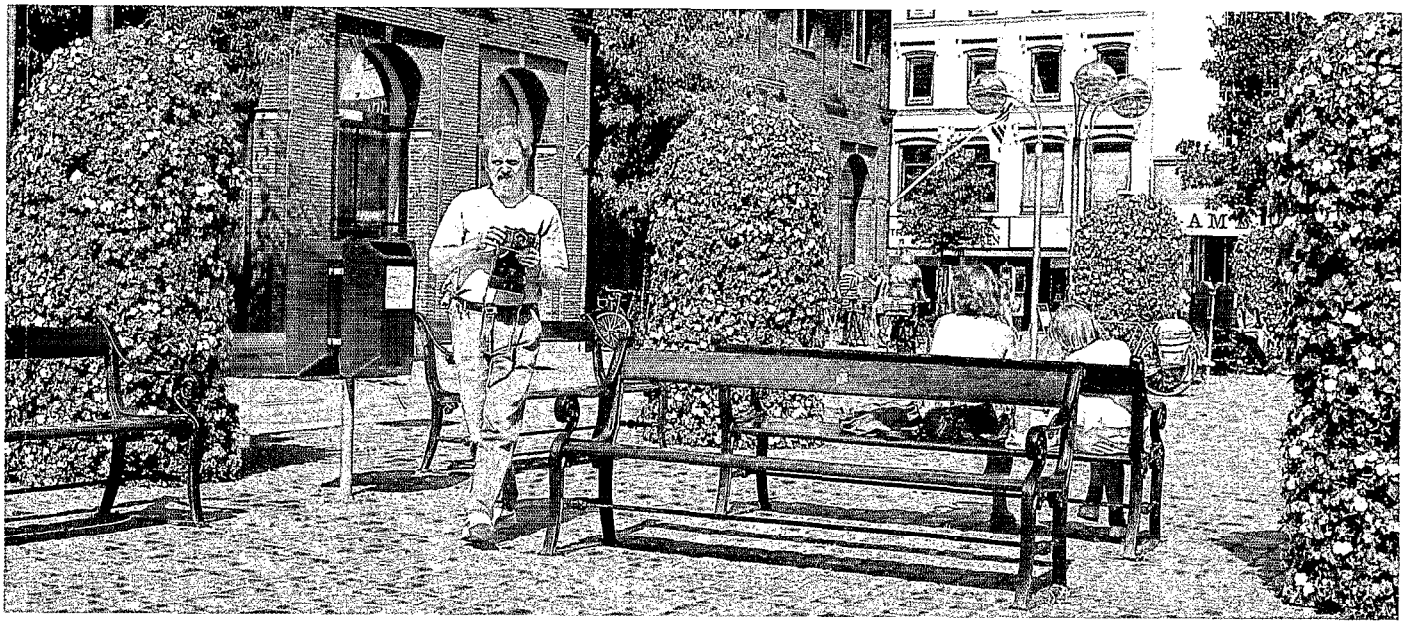
Desired speed	Spacing of speed reducers
50 km/h	250 m
40 km/h	150 m
30 km/h	75 m
10-20 km/h	25 m (max. 55 m)

The relationship between desired speed and spacing of speed reducers.



The whole stretch has been converted. The result is a fine solution and a smooth traffic flow.

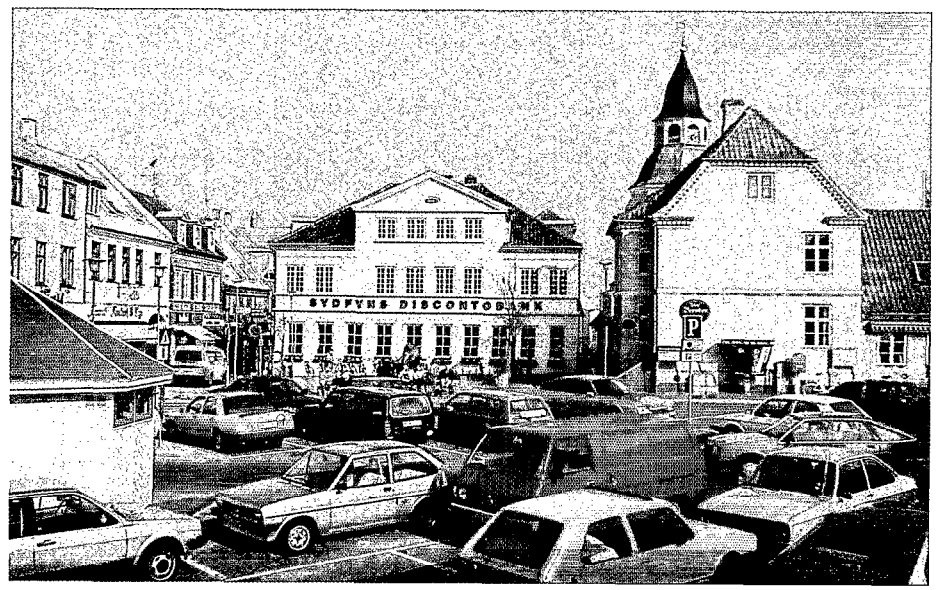
Squares and Open Spaces



The concept of squares and open spaces is a very broad one - ranging from the central and often monumental squares of cities to more private, park-like open spaces in residential areas.

For some years already, it has been a central part of the traffic calming schemes of many towns to try to recreate the town square as a meeting and market place.

Many squares and open spaces have been cleared totally or partially of cars, carparks have been removed, and new surfaces and plantings have been provided. At the same time it has been



This could become a nice outdoor rendezvous.

In some squares it has been possible to do away completely with driving traffic.

possible to weed out some of the marking and street equipment.

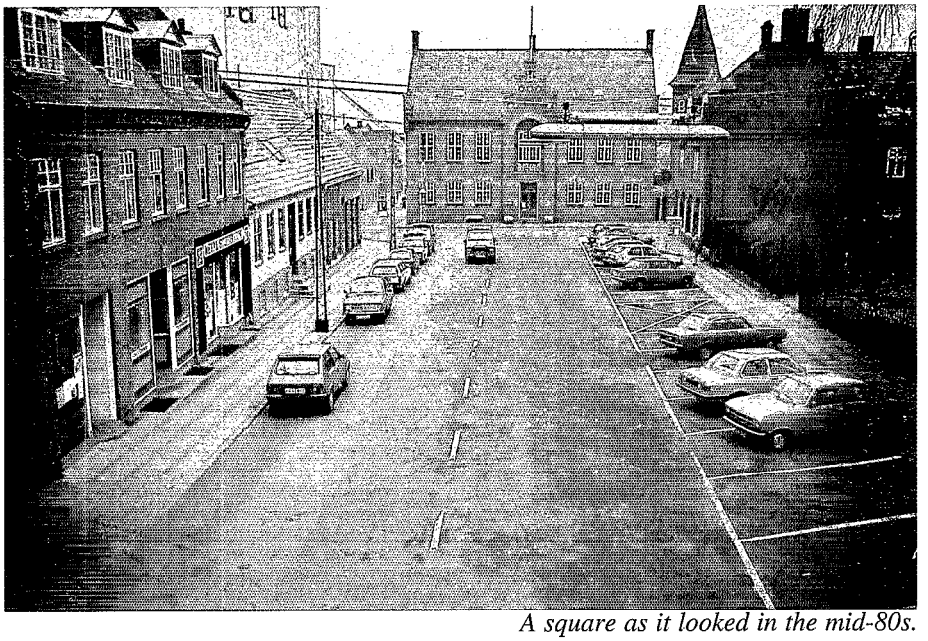
Some squares have no car traffic, some allow a limited, slowly moving car traffic, while others are periodically closed to traffic, for example during certain hours of the day, in the tourist season, or on market days.

Experience shows that such squares to a high degree function according to the purpose, both on weekdays and on festive days. It would therefore be natural that this kind of traffic calming should be continued in the towns where it has been initiated, and be spread to other towns.

Apart from the central squares there exist in almost all towns a number of smaller open spaces which are often somewhat neglected. In many cases it will be possible also to improve such spaces, to reorganize and embellish them and thus create some attractive local rendezvous.

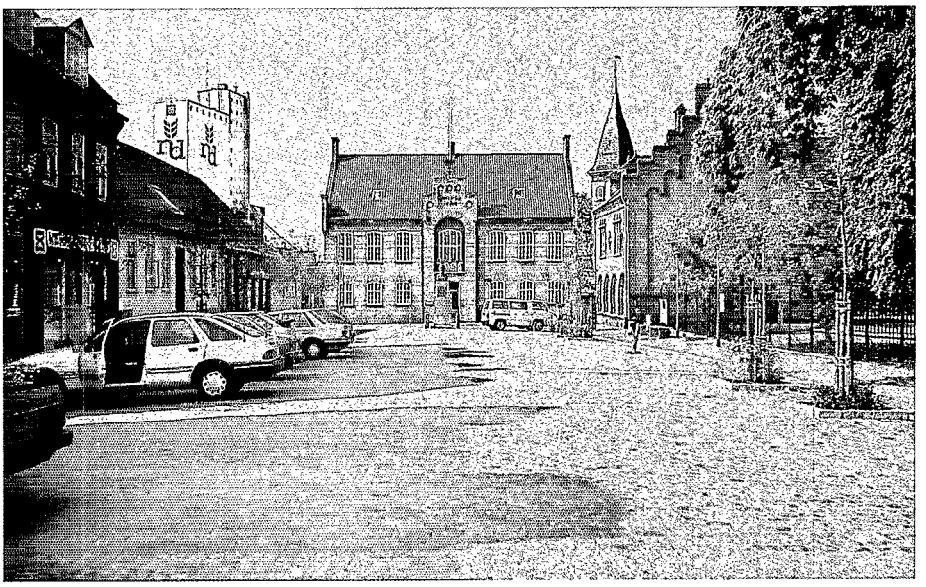
It is also feasible in conjunction with traffic calming schemes to create new squares. For example where a street passes a shopping area and where consequently there are many light road users, and where the street width generally allows it, a square or an open space with light and slowly moving car traffic can be established by means of a new surface, plantings, lighting, and furniture.

A balanced use of architectural and speed-reducing elements is of course of extra importance when a square is to be the scene of a traffic calming scheme. The most widely used speed reducing measure will be a raised area with the ramps placed at the junctions with the connected roads. In addition one should try to achieve as good results as possible by means of architectural and town-building elements, particularly by a carefully considered use of road surface materials and colours.



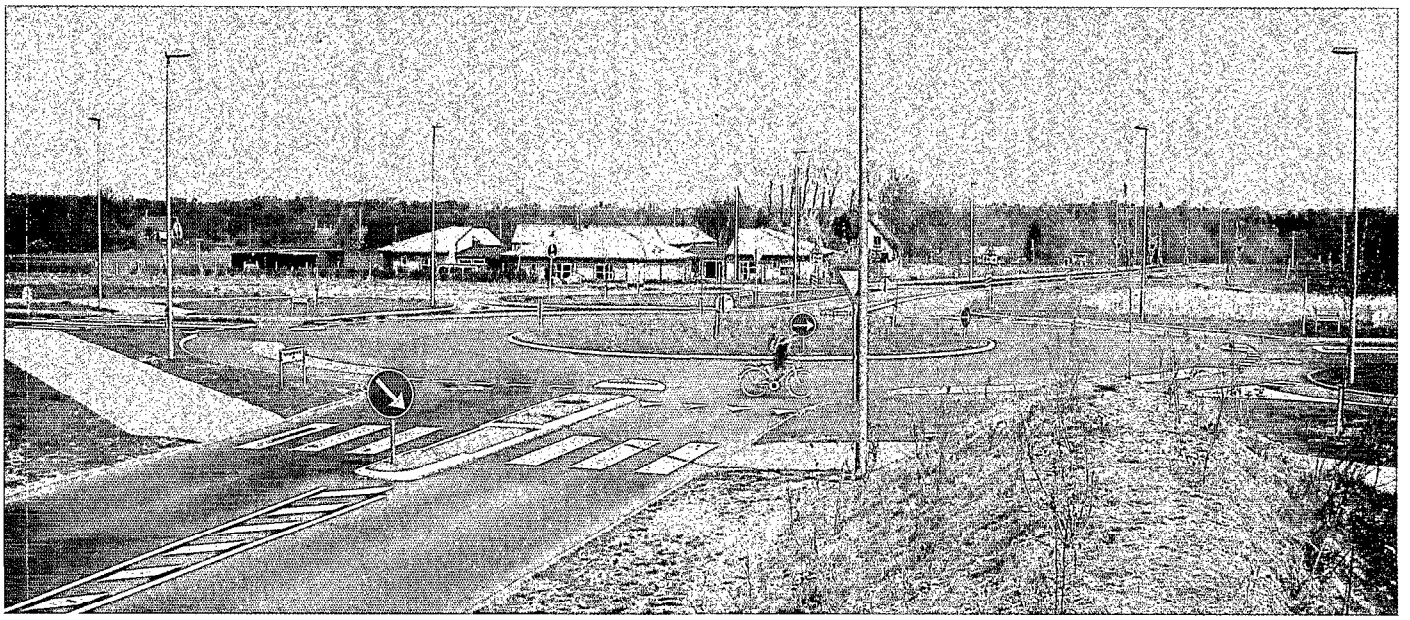
A square as it looked in the mid-80s.

The architect´s vision of the future layout.



And the finished result.

Roundabouts



Most accidents in urban areas happen in the intersections. It is therefore particularly important to lower car speeds and sharpen the drivers' attention in intersections.

In recent years experience has shown, both in Denmark and abroad, that roundabouts are a very suitable type of intersection in this respect.

Firstly, the central island of the roundabouts constitute a visual signal that clearly indicates to the approaching driver that the speed should be lowered. Secondly, the form of the carriageway in the roundabout forces a physical speed reduction for cars.

In addition to the speed reducing and thus safety-improving effect, roundabouts can have a number of other technical advantages: a fair distribution of waiting times between the arms of the intersection; smooth traffic flow and thus lower noise level; slightly lower air pollution and energy consumption compared with traffic-light controlled intersections *(41)*; the possibility of U-turns and establishment of intersections with more than 4 arms.

Roundabouts also entail some architectural advantages. Compared to intersections controlled by traffic lights and strongly canalized intersections, many pylons, much road marking, and the like, can be avoided.

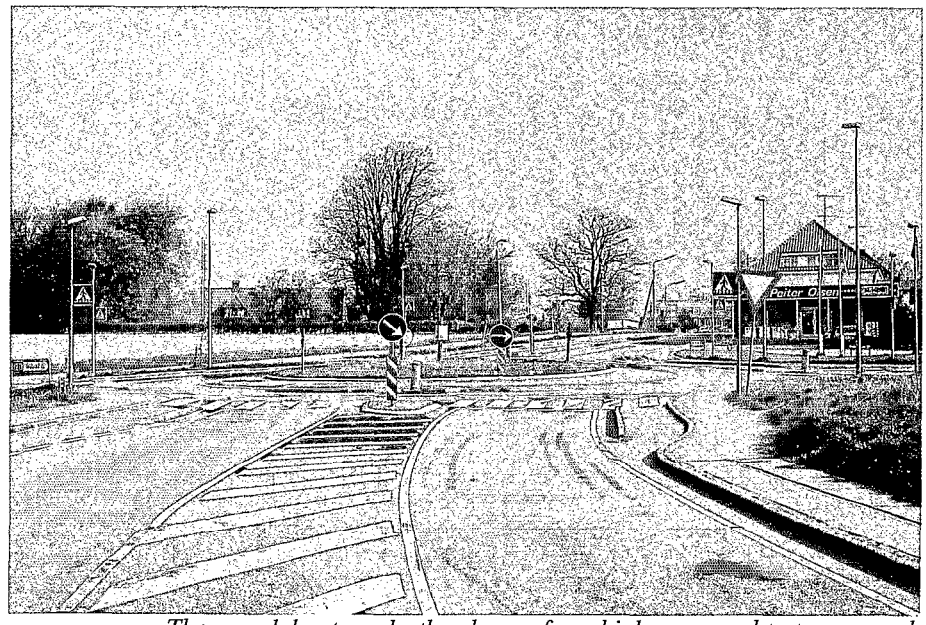
The central island provides the opportunity of planting, which can partly emphasize the visually obstructing effect, partly become a unifying focal point for an otherwise blurred area. Alternatively, a fountain, a sculpture, etc., can be placed on the island.

A sculptural use of the central island can give the spectator an experience and contribute to the identity of the town area while at the same time warning the drivers of traffic conditions.

Roundabouts can therefore be used with very distinct effects, for example in the intersection marking the entrance to a town or in a central intersection in town. But they can also be used in local traffic areas where, by the design of a series of smaller intersections, one wants to reduce the speed in the entire local road network.

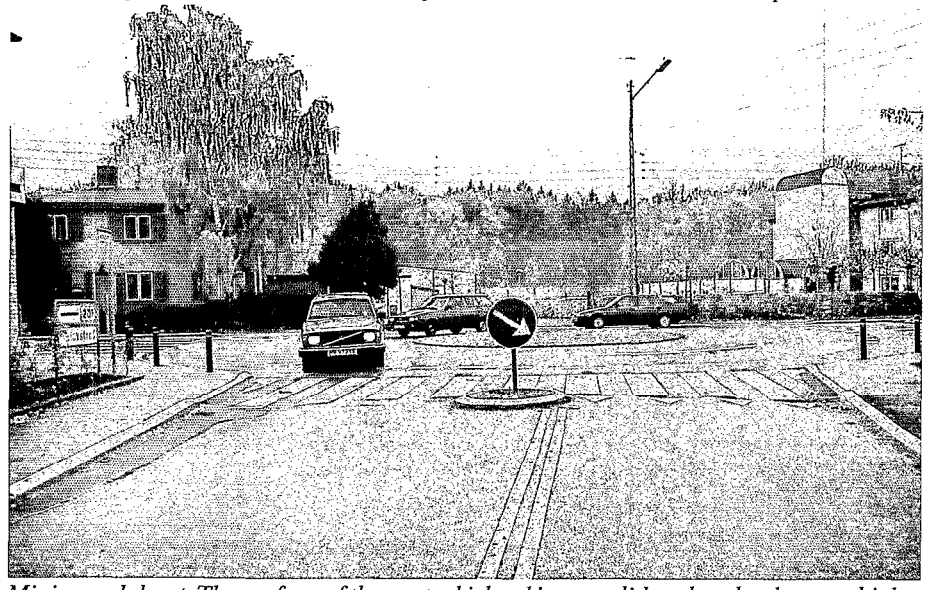
To achieve the desired speed reduction roundabouts in urban areas should be designed with only one lane in entering and exit lanes and in the circulation area. To obtain uniform speed for large and small vehicles the part of the carriageway that is closest to the central island can be given a special surface which large vehicles can drive over, but which cars will try to avoid. From lorries and buses this so-called "short cut area" can be seen as an extension of the normal carriageway and from cars as an extension of the central island *(42)*.

Previous experience shows that roundabouts do not always offer the same safety gains to the cyclists as to the drivers *(67)*. The safety problem for cyclists is mainly constituted by accidents involving circulating cyclists, and drivers entering or exiting *(68)*.



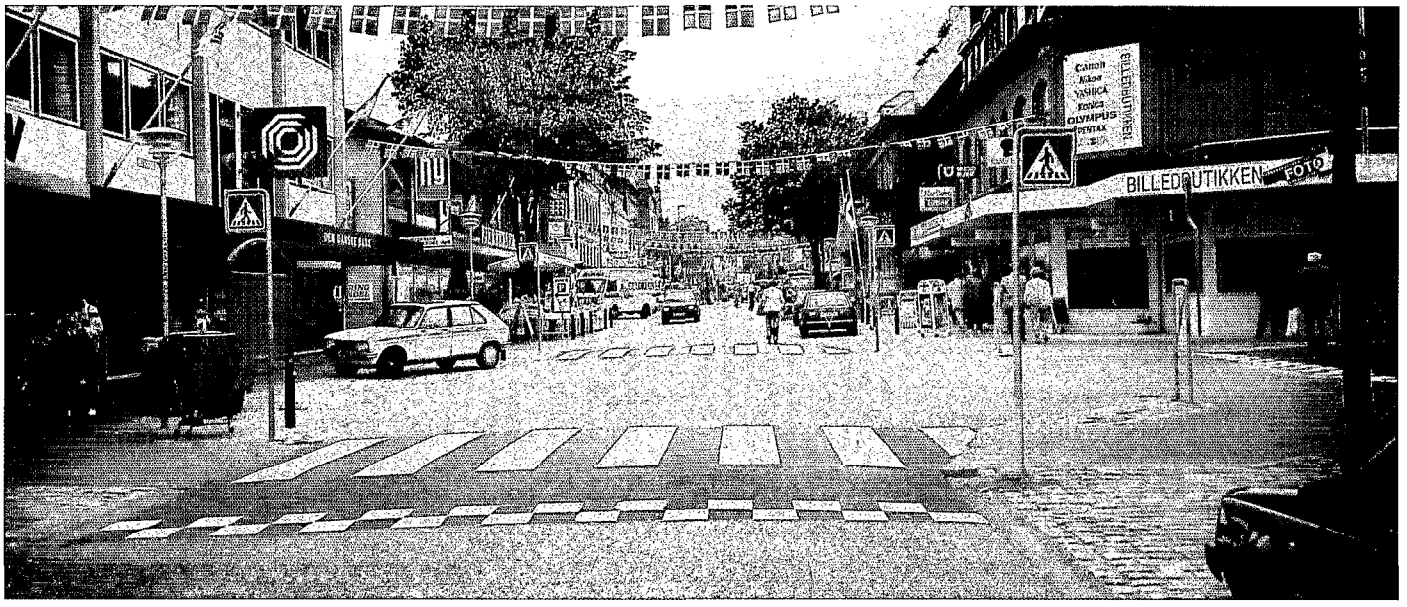
The roundabout marks the change from highway speed to town speed.

In this little roundabout part of the carriageway (the socalled short-cut-area) is paved with paving stones that the cars will try to avoid but which lorries can pass.



Mini roundabout. The surface of the central island is consolidated so that large vehicles can drive over it.

Ordinary Intersections



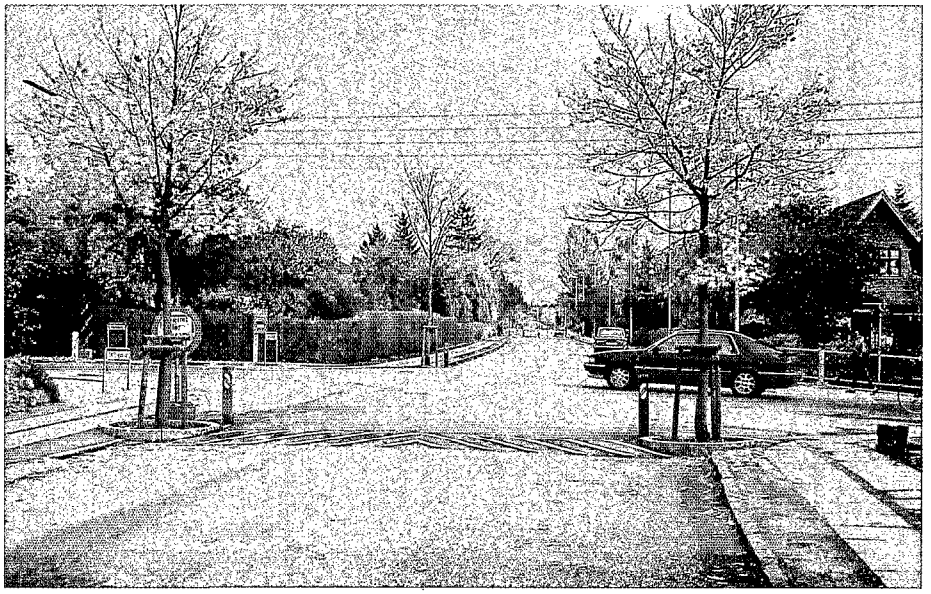
Where for various reasons it is undesirable to establish a roundabout - for example due to restricted space - it is feasible to design speed reducing intersections which may therefore be natural parts of a traffic calming scheme.

In large intersections, mainly on traffic roads, it is often possible - even with due respect to the required capacity - to diminish the dimensions of the carriageway, reduce the number of lanes, make the individual lanes less streamlined, and so forth.

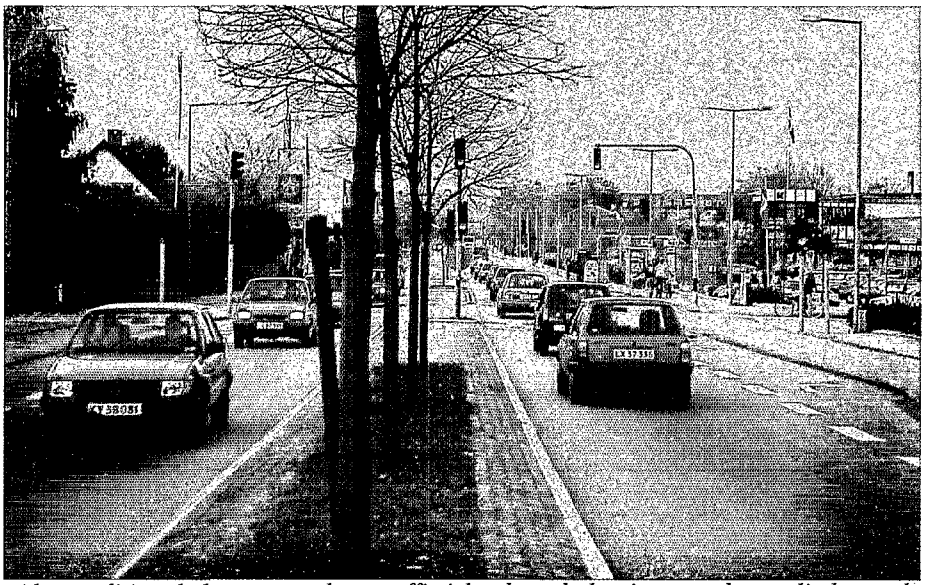
In addition, the visual relationship with the other traffic calming measures can be ensured by a consistent choice of materials or for example by choosing vegetation on traffic islands etc. which corresponds to the vegetation used in the actual speed reducers.

Actual speed reducing devices can also be utilized, such as raising the carriageway in the entire area of the intersection or - on local roads with modest traffic - placing humps in the arms of the intersection *(43)*.

Changed road surfaces, for example granite cobblestones or concrete paving stones in the intersection area, has only a slight direct speed-reducing effect but can help to sharpen road users' attention.



The intersection is a raised area. Drivers feel slightly away from their "home ground" and exercise extra caution.



Also traditional elements such as traffic islands and plantings can be applied to make the intersection reduce speeds.

9 Examples

Content and format of examples

This section includes 23 Danish, 5 German, and 5 French examples of streets, squares, or intersections which have been rebuilt, followed by a presentation of 3 themes: gates, roundabouts, and humps.

The choice of examples attempts to cover a wide range as regards project scope, price, and constituent elements.

All examples are successes to such an extent that they are suitable, in their entirety or in their details, as inspiration for politicians, technicians, or others who face similar tasks.

The examples are presented in both text and illustrations.

The texts are structured along fairly similar lines. The introduction is a short presentation of the given locality (region, town, quarter, street) and an account follows of the background for implementing the project. Subsequently the most important aspects of the planning process are reviewed and the design of the scheme is described briefly. Finally the results of implementing the projects are listed.

More precise and partially comparable project information usually appears in two tables. The first concerns the actual project, its scope, inaugural year, and price. The other table contains some main results of implementing the scheme, based on the information available on traffic volume, car speeds, and the traffic accidents recorded by the police before and after the conversion.

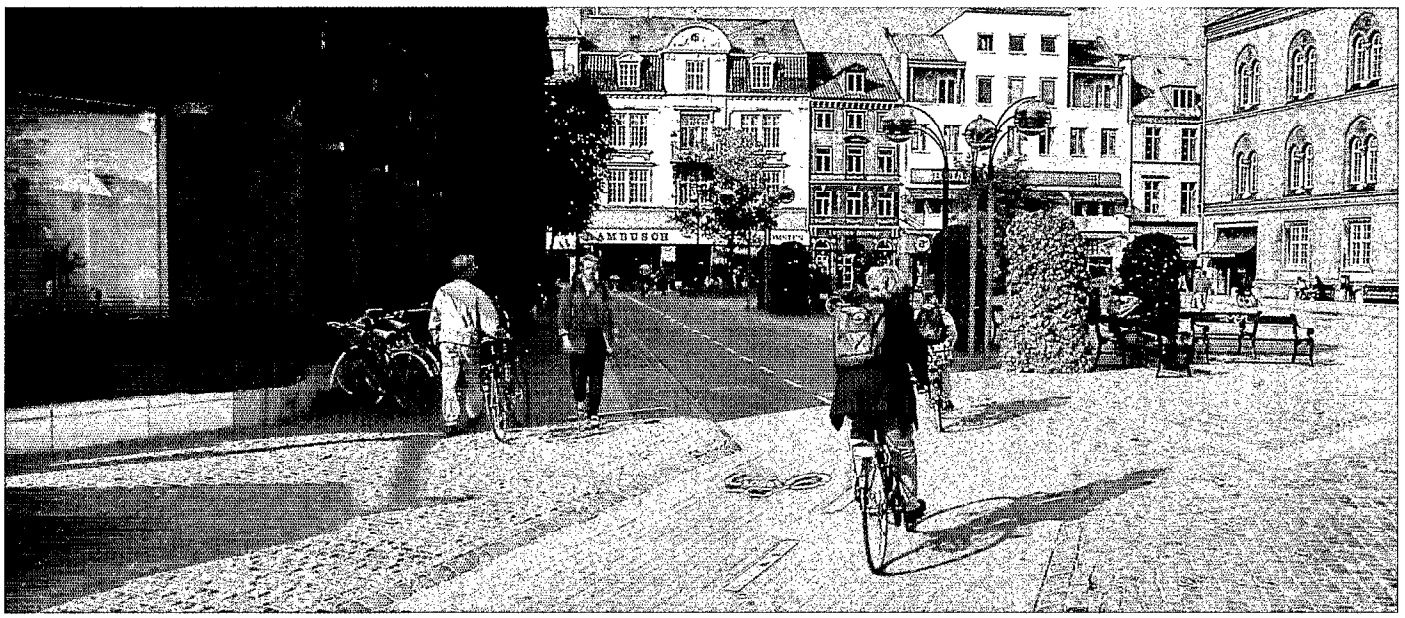
The detail design of the projects cannot be exhaustively described by only words and figures. Great importance is therefore attached to photos, both of overall wholes and of significant details.

Finally it is advisable to use the catalogue of examples as an incentive to visit the different localities. They are all worth a detour.

Danish examples	Contents: Precinct	Stretch	Square	Shops	Gate	Hump	Raised Area	Narrowing	Staggering	Traffic Island	Roundabout	Cycle Tracks	Street Furniture	Street Surface
Town Centre of Odense	●			●								●	●	●
Town Centre of Nakskov	●			●		●	●			●	●	●	●	●
Station Square in Kolding		●	●				●						●	●
Shopping Street in Hjørring		●		●		●	●						●	●
Shopping Street in Vordingborg		●		●	●		●	●			●		●	●
Shopping Street in Assens		●	●	●				●					●	●
Town Street in Herlev		●										●	●	●
Shopping Street in Hadsund		●		●			●	●					●	●
Shopping Street in Odense		●		●			●	●	●				●	●
Town Street in Christiansfeld		●	●	●		●	●						●	●
Town Street in Næstved		●	●	●				●	●				●	●
Town Hall Square in Nysted			●				●						●	●
Roundabout in Vamdrup			●								●		●	●
Coastal Boulevard in Hellerup		●		●				●		●		●		
Highway through Aabenraa		●			●			●	●	●		●		
Highway through Vinderup		●		●	●			●	●	●		●		●
Highway through Tinglev		●		●	●			●	●	●		●		
Highway through Vipperød		●			●			●	●	●		●		
Municipal Road through Tarm		●		●	●			●	●	●				
Highway through Skægkær		●			●			●	●	●		●		
Municipal Roads through Nøvling		●			●	●	●			●				
Highway through Sdr. Sejerslev		●				●								
Highway at Dybbøl Hill		●			●		●					●	●	●

Here you find the Danish examples. Figures refer to page numbers.

Town Centre of Odense



In connection with Odense's 1000th years' anniversary in 1988 a number of new developments were inaugurated in the town centre: pedestrian streets, a bus street, and a bicycle route network. This has given the already lively town centre a significant lift, has stimulated the activity in the area, and has markedly improved the visual environment.

The Town

With its 140,000 inhabitants Odense is Denmark's third largest town.

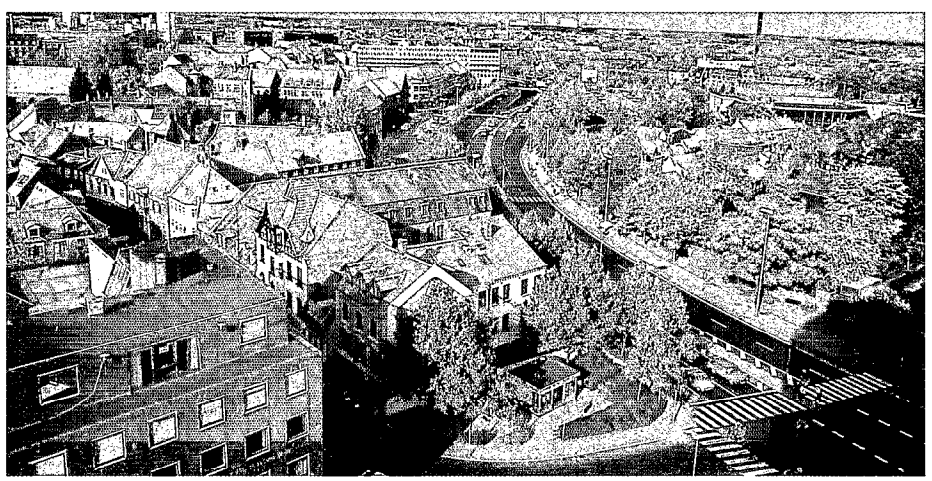
During the last decades the town has constantly been at the forefront as regards traffic policy and the implementation of concrete traffic solutions, giving priority to the environment and the light road users. Odense carried out some of the first successful traffic calming schemes and the municipality has also been abreast with the situation concerning the establishment of safe bicycle routes, paths etc.

Road authority	Odense municipality
Project scope	Town centre - pedestrian streets, bicycle routes and a bus road
Inaugural year	1988
Costs	DKK 40 m

The Background

In the beginning of the 1970s Odense's municipality built the north-south "Thomas B. Thriges Gade" road penetration. This road cut through the eastern part of the town centre and separated the Hans Christian Andersen quarter from the rest of the centre. This was probably Denmark's most criticized road of the period.

However, a positive aspect of the project was that it freed the town centre gener-



Said Mr R. Honoré, City Engineer, "You can't make an omelet without breaking eggs".

ally of a fair part of the through traffic and thus prepared the ground for a further moderation of traffic.

In 1984 the already established pedestrian streets in the town centre totalled 600 m. But in many shopping streets with many pedestrians there was still car traffic and there was a lack of open public spaces.

Cycle tracks had been established along several important streets, for example Thomas B. Thriges Gade, but in the actual town centre, where 12,500 cyclists went to and fro every day, there were no cycle tracks. And in the years 1981-83, there were 76 accidents involving cyclists in the town centre.

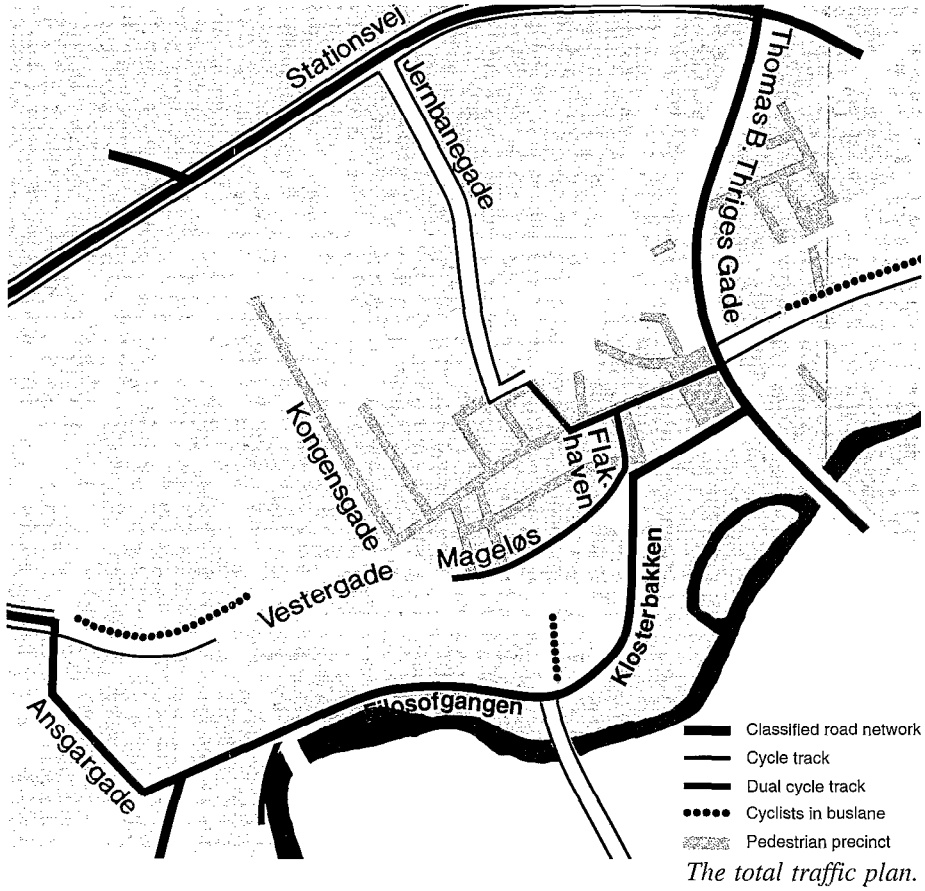
As part of the bicycle route experiment in different Danish towns (see description of cycle route project in Nakskov) the Danish Road Directorate in 1984 approved a DKK 3.5 m grant-in-aid to establish cycle routes through Odense town centre provided that Odense municipality contributed the same amount.

Planning

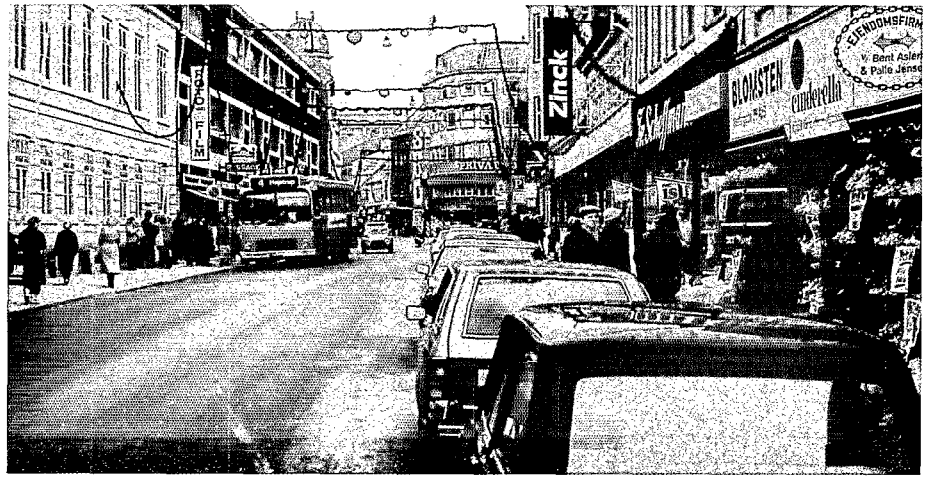
The traffic plan prepared in 1984 for the town centre *(44)* was based on the precondition, regarding car traffic, that all general car traffic was channelled via the ring road system of Thomas B. Thriges Gade, Stationsvej, Vesterbro, Ansgargade, Filosofgangen, Klosterbakken. From the ring road car traffic with business in the town centre is led to a number of carparks close to the pedestrian streets.

Parking conditions were regulated through plans for multi-storey car parks along the ring road. The centrally sited car parks are equipped with parking meters, and kerb parking has largely been abolished except for a few bays which may still be used for short-term parking (1/2-1 h).

The pedestrian street system was enlarged to become a network in the central and western parts of the town centre.



The total traffic plan.



Vestergade, before and after the conversion.

A patterned planting of plane trees almost conceals the cars parked underneath.

In Mageløs the pedestrians should beware of both buses and cyclists.

The cyclists' track area is marked with brown hard burned paving bricks in stretcher bond while the rest of the area is paved in yellow hard burned bricks.

It thus came to include all the most important shopping streets and also e.g. the town hall square of Flakhaven in a peaceful, car-free public area. There is now a total of 2.5 km pedestrian streets in the town centre. Commercial traffic to the shops takes place mainly at the back of houses but some necessary traffic must drive in the pedestrian streets.

An east-west and a north-south bicycle route were planned through the town. They were implemented partly as ordinary cycle tracks on both sides of the road, partly as dual tracks through streets and squares otherwise devoted to pedestrian traffic.

Mageløs, south of the pedestrian street network, was selected as a combined bus, cyclist, and pedestrian street.

Design

As regards design the pedestrian streets with dual cycle tracks deserve particular interest.

The longest stretch of this kind is found in the eastern part of Vestergade. The width of the cycle track in the 12-14 m wide street is 3.5 m. There is a small difference in height (3 cm) between the track and the remaining area and the track is paved with dark paving stones and a bevelled edging which emphasizes the borderline between the track area and the pedestrian area.

The carriageway area in the bus street is 6.0 m wide and demarcated from the rest of the area by means of a bevelled kerb. Formally, however, the street is a normal one where pedestrians must give way to buses when crossing the street, but vehicles other than buses are prohibited.

In connection with the rebuilding of the street network very consistent planning was made for both street furniture and plantings.

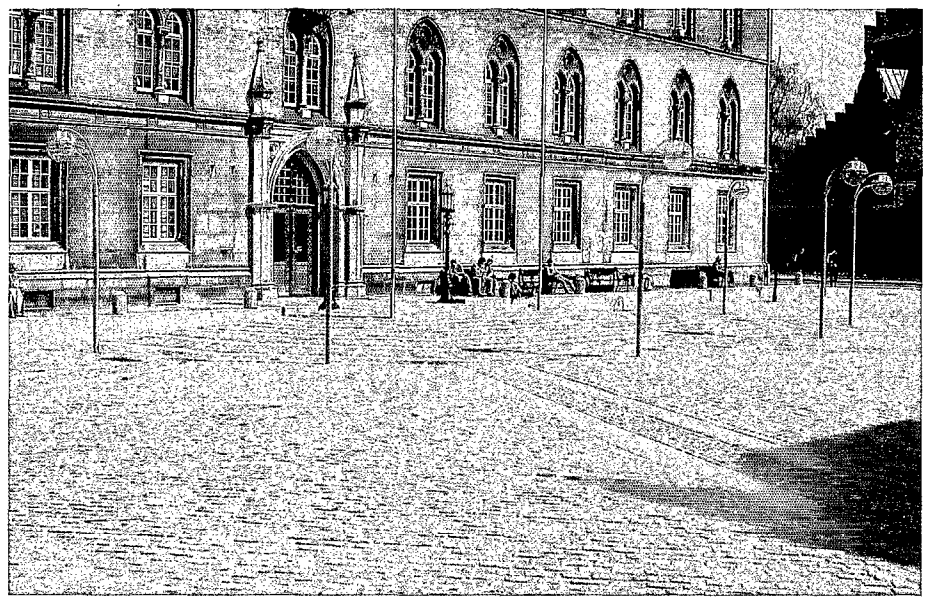
Street furniture and fixtures (shelters, advertising pillars, benches, litter boxes, etc.) make up a fine architectural whole in which all elements appear in a discreet dark green colour.

Regarding the plantings, a distinct and varied overall impression has been obtained without over-planting.

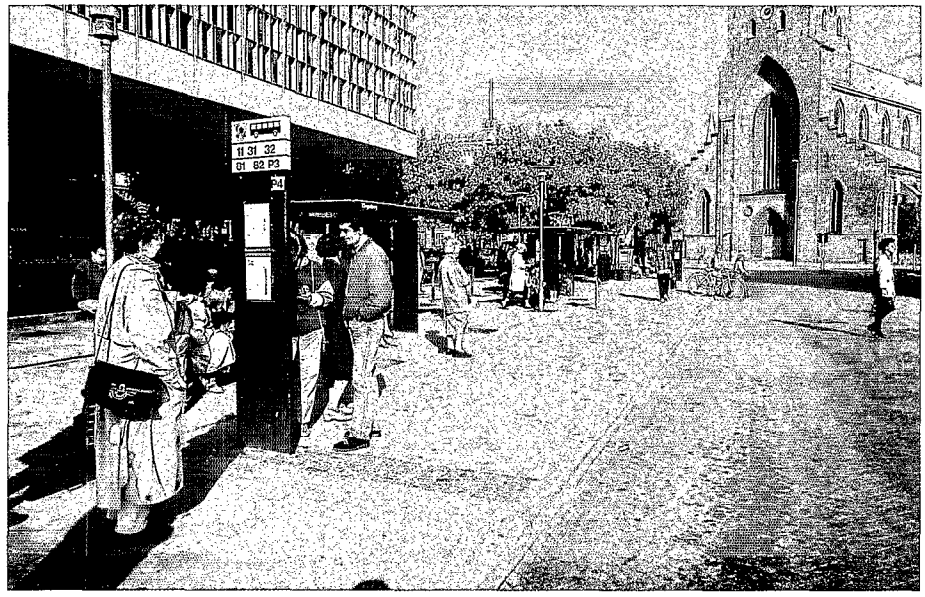
Results

From the outset there was some doubt about the consequences of mixing pedestrian and cycling traffic in the pedestrian precinct. The results, however, have surpassed expectations, the traffic takes place with great mutual consideration, and according to municipal information only a few accidents have happened involving cyclists and pedestrians.

All things considered, the implementation of the traffic plan has given a substantial lift to the town centre and has resulted in considerably higher activity in the area. In addition, there has been an interesting further extension of the pedestrian street system in alleys, by-streets, and passages connected to the general pedestrian street system.

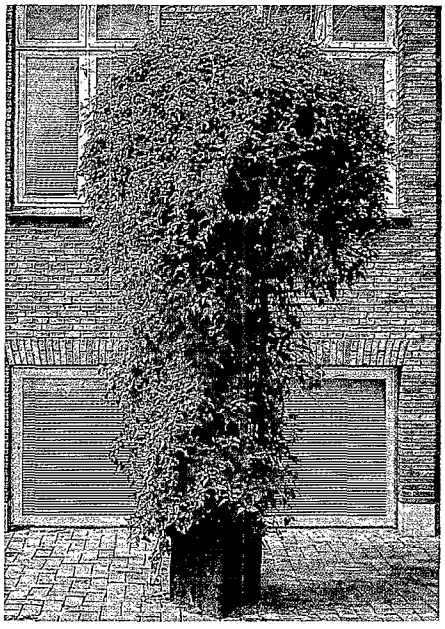


The granite pavement in front of the town hall makes a fine pattern.



The bus stop is both a comfortable and beautiful place to be.

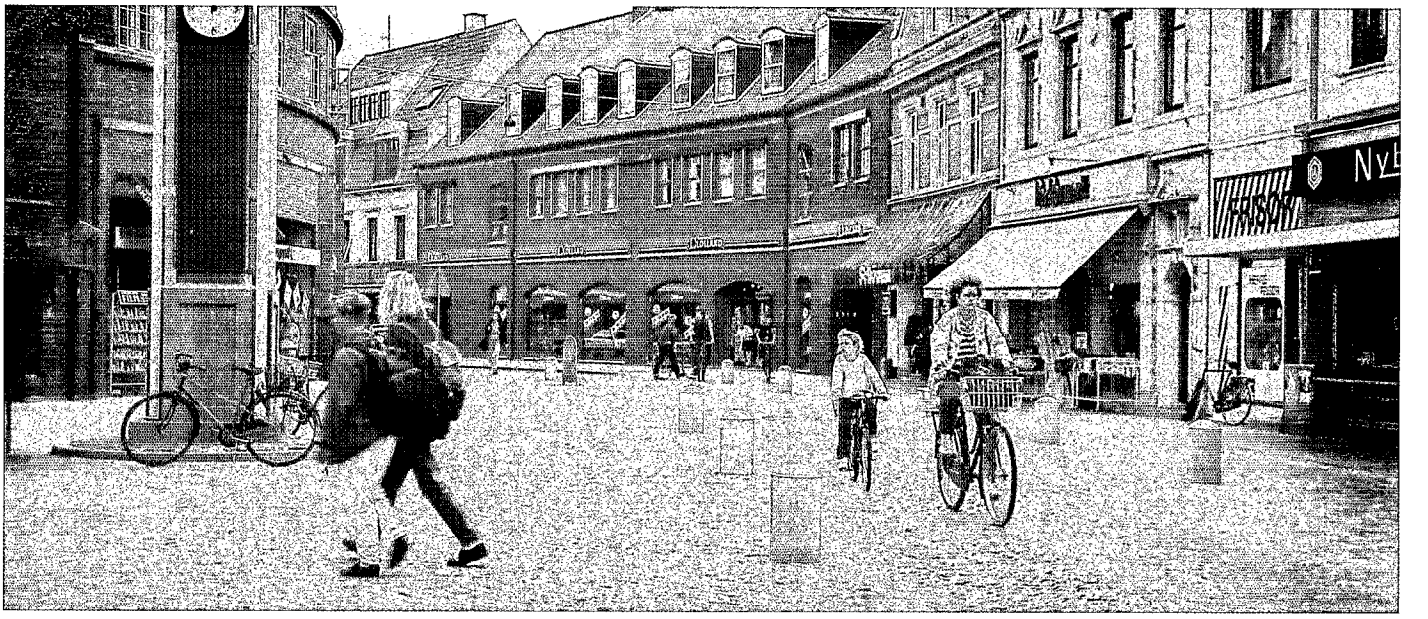
Creepers in flower stands lend the street scene a lush impression with rich colours, during the flowering period.



	Before	After
Car traffic	(1982)	(1990)
- into the town centre	28,000 vhl/24 hrs	32,500 vhl/24 hrs
Pedestrian traffic, 10 am to 6 pm		(1988)
- point on Vestergade	-	25-26,000
- point on Kongensgade	-	12-18,000
Bicycle traffic	(1982)	(1990)
- into the town centre	12,500 vhl/24 hrs	15,400 vhl/24 hrs
Speed specified by signs	50 km/h	50 km/h
Accidents	(1980-83)	(1989-90)
- total	49.8 accidents per year	38.0 accidents per year
- involving personal injury	15.8 accidents per year	12.0 accidents per year

Source: Odense municipality.

Town Centre of Nakskov



In the town of Nakskov a bicycle route network has been established in and around the town centre. The project has not only resulted in much better conditions for the cyclists, but has also improved the town aesthetically and given Nakskov its own character.

The Town

Nakskov is the regional centre of western Lolland and with 15,300 inhabitants it is the largest town on the island. For several reasons it has, over the years, been a cyclists' town: it is of geographically limited size, it is situated in a flat landscape, and industrial jobs predominate.

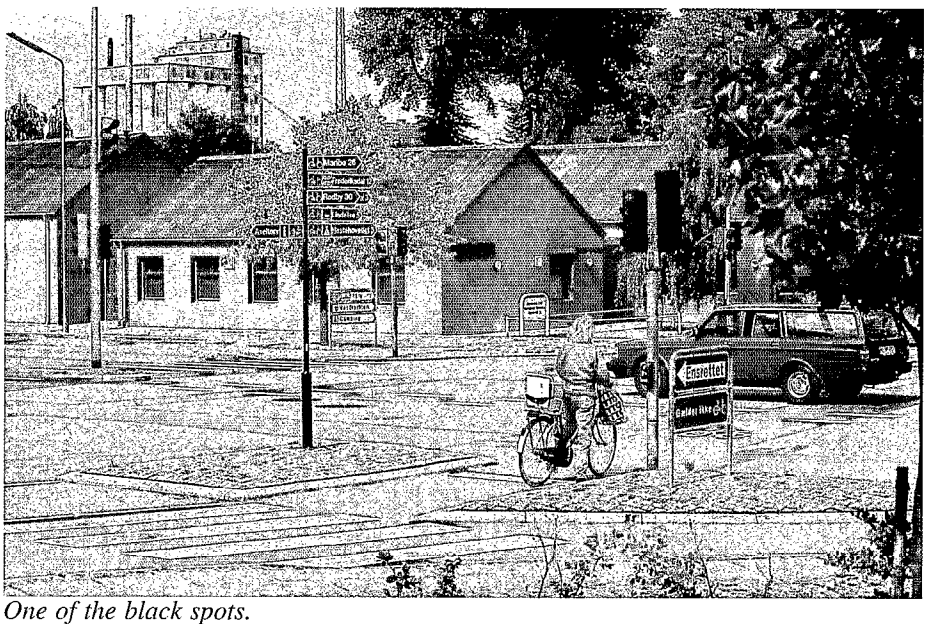
Road authority	Nakskov municipality
Project scope	Town centre
- 1st stage	1,300 m bicycle route
- 2nd stage	1,000 m streets and squares
Inaugural year	
- 1st stage	1990
- 2nd stage	1991
Costs	DKK 25 m

The Background

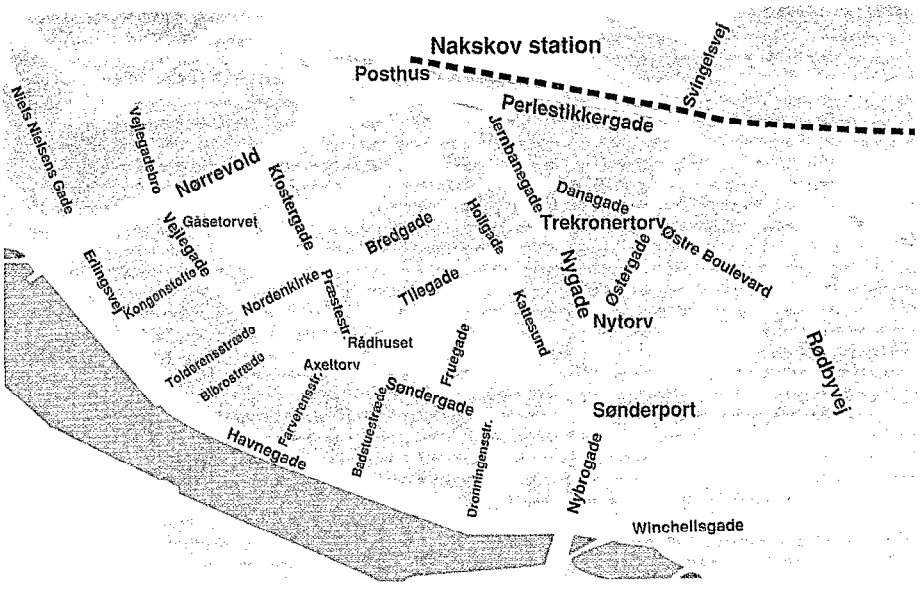
Already in 1975 Nakskov had started a large cycle track construction programme, particularly for the outlying areas where e.g. the school roads had to be made safe.

Simultaneously, and perhaps partially due to the improved conditions for cyclists, cycle traffic increased considerably. And in the ten years from 1976 to 1986 the yearly number of cyclist accidents almost doubled.

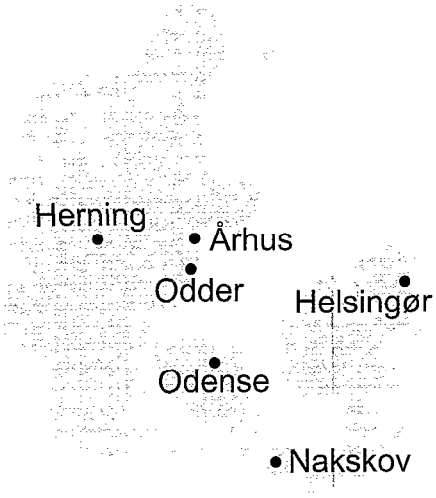
Many accidents happened in and about the town centre. For example, almost half the accidents took place on the inner ring road north of the town centre (Nørrevold-Perlestikkergade) mainly as



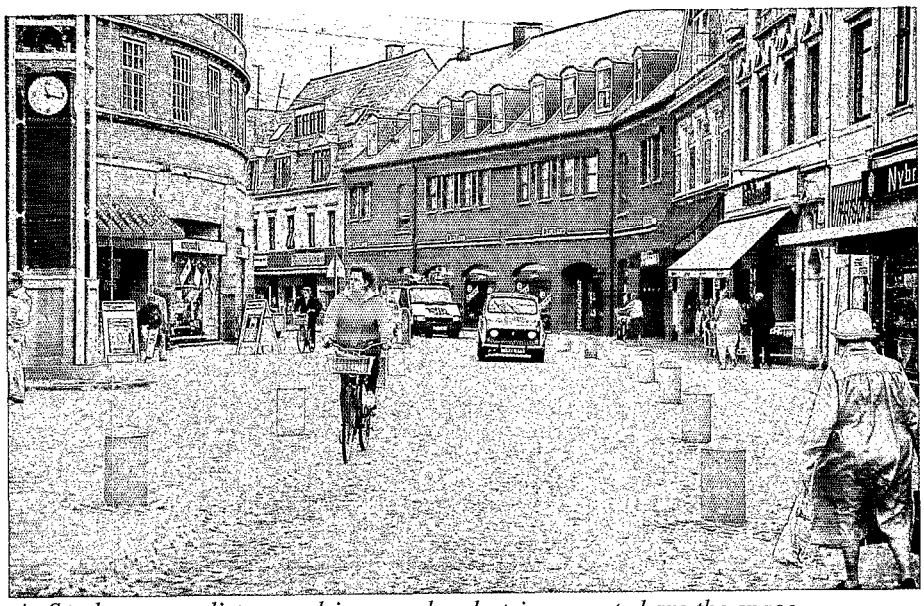
One of the black spots.



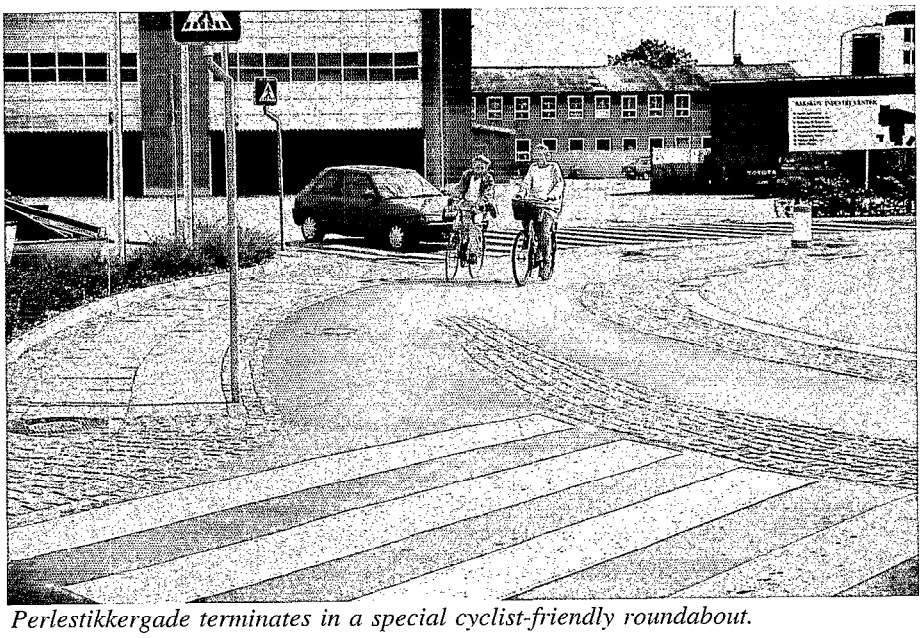
The town centre.



The 6 towns of the Bicycle Route experiment.



At Sønderport cyclists, car drivers and pedestrians must share the space.



Perlestikkergade terminates in a special cyclist-friendly roundabout.

crossing-accidents for cyclists on their way between the centre and the northern residential areas *(45)*.

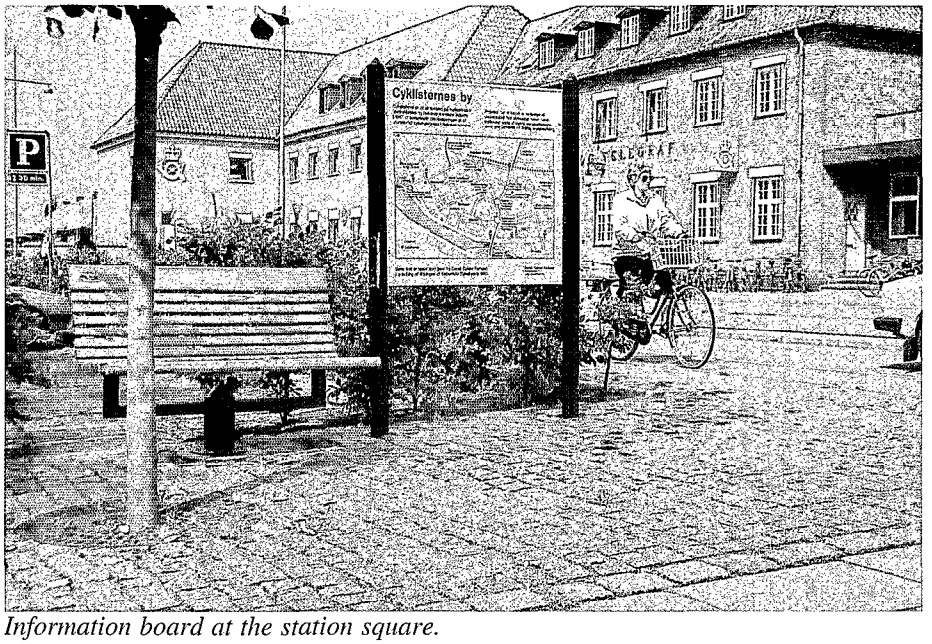
Thus there was a very marked need to extend the improved safety for cyclists from the peripheral areas to the town centre and especially to improve safety on the ring road.

Bicycle Route Experiments in Denmark

During the 1970s the number of traffic accidents causing personal injuries was halved in Denmark. Cyclists, however, enjoyed a relatively small share of this improvement and in the beginning of the 1980s it was approximately 5 times as dangerous to travel 1 km on bike as by car.

Against this background, from 1984 onwards, experiments supported by the Road Directorate were started concerning the establishment of bicycle routes in 6 Danish towns, including Nakskov.

Due to their status as experiments and to the very different conditions and requirements of the 6 towns, the projects were also designed very differently. In Nakskov the emphasis was on creating an unbroken network and on a beautiful and characteristic overall impression.



Information board at the station square.

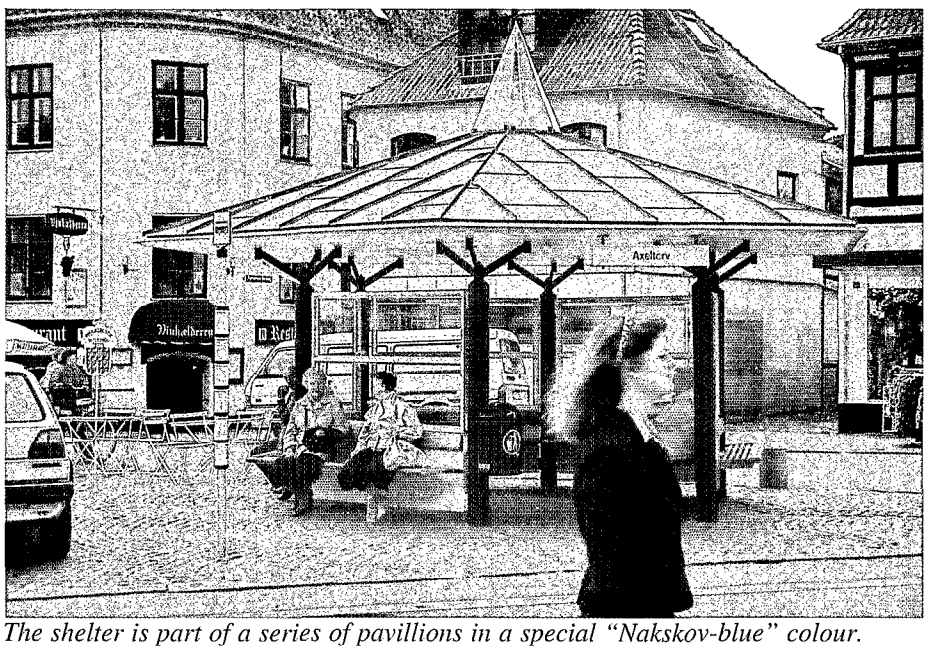
Planning

The starting point for the experiment was a local plan for the bicycle routes, which in turn was based on a total path plan for the town.

In the municipality's application of 1987 to become an experimental town for a bicycle route project great emphasis was put on the need to see urban space, the technical design, the street furniture, etc. as a unity.

This view was repeated in the contract with the Road Directorate, which underlined the unanimously agreed objective that the converted streets should have a high standard. DKK 25 m were allocated to the project, which was started under the management of a steering committee with representatives from the municipality, the Road Directorate, the police, and private consultants *(45)*.

The work was divided into two stages: the first, comprising Nørrevold-Perlestikkergade, was implemented in 1989/90, the other, comprising the streets and the squares in the actual town centre, was implemented in 1990/91.


The shelter is part of a series of pavillions in a special "Nakskov-blue" colour.

Information

For 3 years there were almost constant excavations in the town centre so the inhabitants' patience has been severely tested. Also the abolition of a number of parking bays at the station caused some criticism.

In co-operation with the Road Directorate an information campaign about the project was launched in the autumn of 1990. The campaign utilized partly a door-to-door paper about the bicycle route and its purpose, and partly posters sited along the ring road. The campaign was repeated in 1991, when also the streets of the central town were involved.

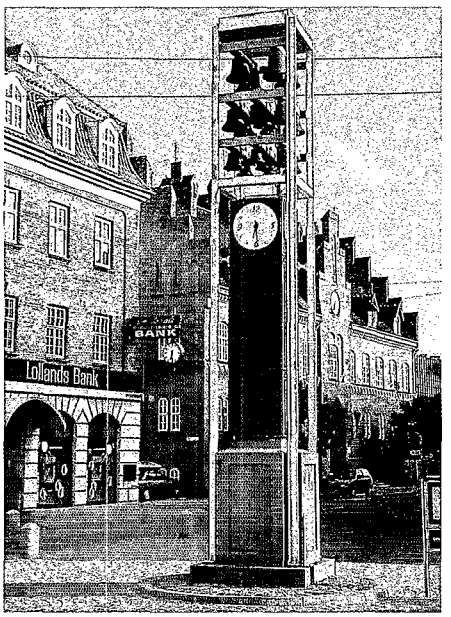
Design

Cycle tracks were established on both sides of the ring road, whereas in the town centre generally dual tracks or lanes were made, permitting cycle traffic against otherwise one-way traffic.

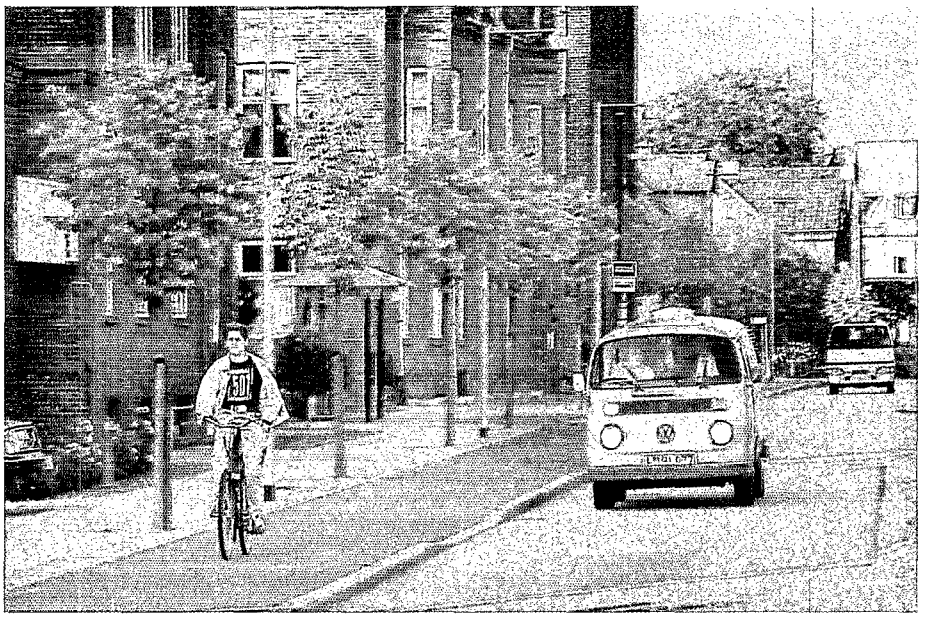
As a continuous element the cycle tracks and lanes are paved with red asphalt - even through the intersections, which has necessitated a dispensation by the Ministry of Justice from the usual blue colour. The cycle track network is like a red thread through the town.

Improving the intersections has been given very high priority. In the eastern part of Nørrevold-Perlestikkergade a roundabout has been established which, for the benefit of cyclists, has been designed very carefully: ramps have been made at the junctions, and the cycle tracks in the roundabout are divided at the exits so that car drivers may early be aware of which way cyclists are going, and thus avoid conflicts.

After the conversion there are, along Nørrevold-Perlestikkergade, 3 traffic-controlled traffic lights. Special before-green lights for cyclists have been provided to prevent conflicts between right-turning cars and cyclists going straight ahead.



The new bell-tower



The reestablished row of trees along Nørrevold.

The square in front of the railway station had hitherto been the most accident-prone spot. Today, a wide zebra crossing and a traffic island have been established - on a raised area with ramps to reduce car speeds.

In Jernbanegade cycle tracks have been made along both roadsides. In Nygade and Østergade there is now one-way car traffic to make room for a cycle track in the opposite direction. The width of the cycle tracks varies between 1.75 and 2 m.

The four open spaces in the town centre have been treated very differently both in terms of layout and paving. But common to them all is that the conversion has sought to reduce car speeds and to a large extent give the open spaces back to the light road users.

Plantings and Street Furniture

It was natural to recreate the row of trees along Nørrevold which at the beginning of this century demarcated the medieval town from the more recent urban developments.

In connection with the conversion a street equipment programme was prepared including shelters, advertising pillars, steles, and lamp posts. Most of the street equipment has been specially designed for Nakskov.

Results

The conversion has resulted in considerably lower speed levels on the squares, such as Nygade at Sønderport. On the road sections speed levels have not changed significantly.

No proper analysis can be made of accidents until some years after the conversion. But the general impression is that the conversions function as intended and that the traffic environment has become quieter, simpler, and easier to comprehend *(69)*.

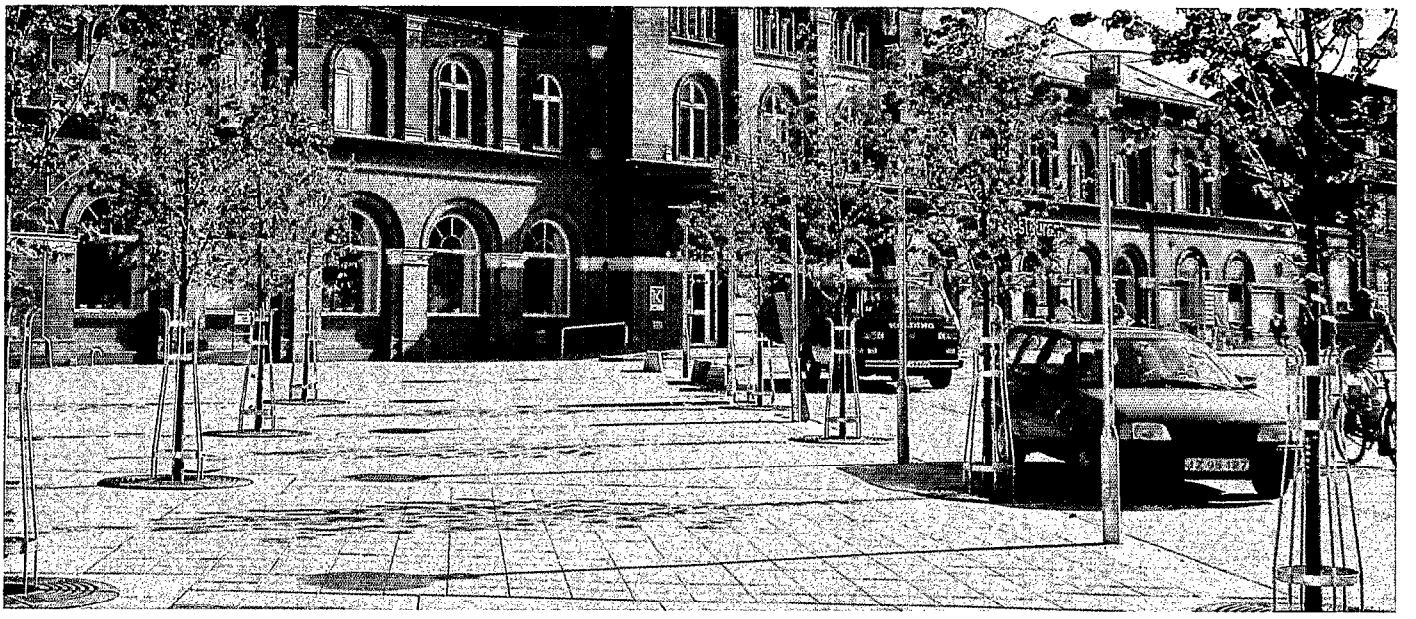
The town inhabitants are generally satisfied with the project. As a secondary effect there has been much positive mention of Nakskov both in Denmark and abroad.

In 1989 Danish Cyclists' Association's convention was held in Nakskov, and in 1991 the town was awarded the Association's Town-for-Cyclists prize.

	Before	After
Car traffic	(1988)	(1991)
- Nørrevold	6,500 vhl/24 hrs	4,350 vhl/24 hrs
- Perlestikkergade	7,500 vhl/24 hrs	6,400 vhl/24 hrs
- Svingelsvej/Østergade	2,400 vhl/24 hrs	650 vhl/24 hrs
- Nygade at Sønderport	3,300 vhl/24 hrs	1,200 vhl/24 hrs
Speed specified by signs		
- Nørrevold, Perlestikkergade, Svingelsvej	50 km/h	50 km/h
- Østergade at Nytorv	50 km/h	30 km/h
- Nygade at Sønderport	50 km/h	Pedestrian street
Mean speed at point		
- Nørrevold	45 km/h	44 km/h
- Perlestikkergade	48 km/h	44 km/h
- Svingelsvej	47 km/h	46 km/h
- Østergade	34 km/h	30 km/h
- Nygade at Sønderport	32 km/h	18 km/h

Sources: Nakskov municipality. Speeds: IVTB, DTH.

Station Square in Kolding



During the second half of the 1980s Kolding municipality worked out a very ambitious traffic plan including both roads, paths, and public transport - and immediately proceded to implement the plan. One of the implemented projects is a conversion of the station square with the purpose of creating a beautiful and peaceful public traffic area.

The Town

Kolding is one of the four regional centres in Vejle county and with 45,000 inhabitants is the 9th largest town in Denmark.

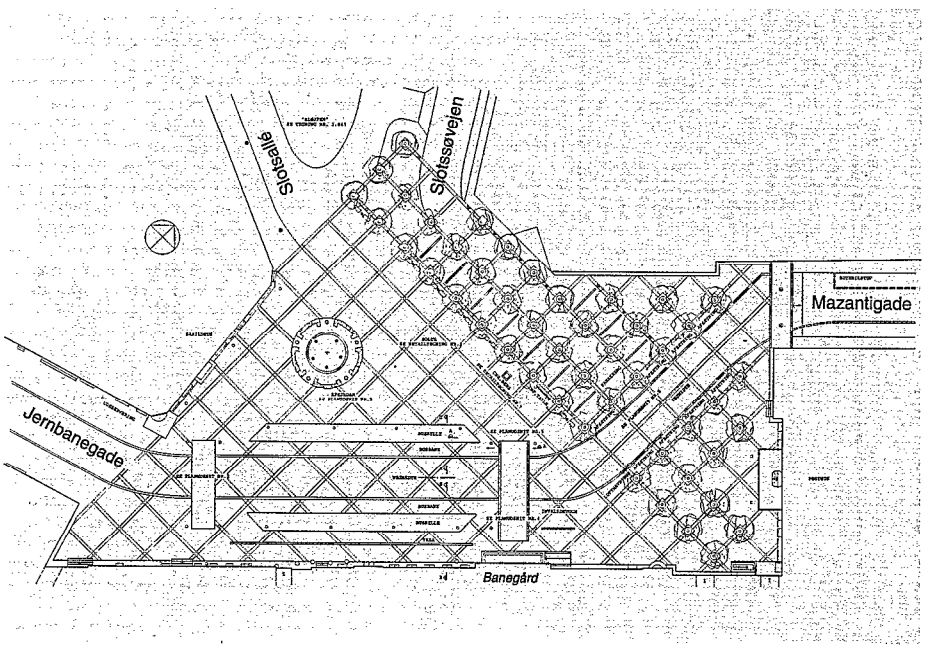
Traffic-wise Kolding commands a good location. It is close to one of the nodes of the "big motorway-H" and it is expected that a motorway to Esbjerg will have been established by the year 2000.

After the establishment of a new connecting line bypassing Fredericia, Kolding will be the first sizeable train station west of the Little Belt, which will reinforce its position as a nodal point between the IC3 trains and the regional traffic.

The Background

According to the municipal plan of 1984 the objective of the traffic plan for the town centre was to improve the urban environment for both inhabitants and visitors and at the same time ensure good traffic access to the town centre

Road authority	Kolding municipality
Project scope	140 m street and 50x90 m square with busterminal
Inaugural year	1989



The project.

for all groups of road users. In the years 1985-87 this objective was expressed in a traffic plan for the town centre which, to achieve the best possible balance between urban environment and traffic access, incorporated a number of traffic changes, e.g:

Car traffic with no business in the town centre is confined to an extended ring road system around the centre.

The supply of parking space has been determined with regard to the desired urban environment, and the demand for parking is controlled using parking fees and time restrictions on the best sites. Drivers are notified of free parking spaces by an electronic guiding system.

Regional buses have been removed from some of the central streets, and the transfer change to town buses takes place mainly at the railway station.

A cycle track network has been developed and a pedestrian precinct has been made in the central zone of the town centre.

In 1989 the traffic plan for the town centre was incorporated in a total traffic plan for the whole municipality *(46)*.

Planning

The detail planning of the railway square was carried out on the basis of the traffic plan for the town centre and with the same objectives for an improved urban environment and good traffic access for all road users.

The station square and adjoining roads, i.e. Jernbanegade, Slotsallé, and Slotssøvej, used to be one large traffic area. Jernbanegade had one-way traffic towards the east, as traffic in the opposite direction used the northern parallel street, Fredericiagade. Both Jernbanegade and Fredericiagade were traffic roads with considerable, fast-moving car traffic.

Jernbanegade. The pedestrian crossings, the vegetation, and the narrow carriageway dampen car speeds.

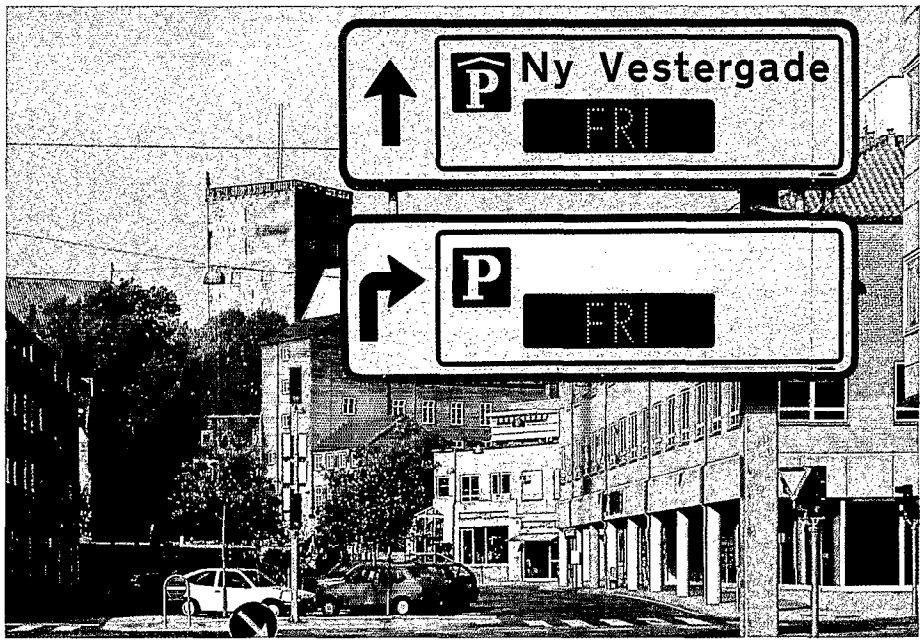
In the traffic plan Jernbanegade was declassified to a secondary traffic road with speed reduction, and both Jernbanegade and Fredericiagade were made two-way roads. This means that it is now only the car traffic to and from the precinct that uses Jernbanegade-Station Square.

Both Jernbanegade and the station square have signs with a recommended maximum speed of 30 km/h.

Design

The carriageway of Jernbanegade has been narrowed down from 11m to 7 m and the two roadside lanes are now devoted to parking. Pedestrian crossings are placed at 30-40 m intervals, marked by means of changed road surface, plantings, and lighting.

The station square contains a traffic terminal with bus-change stops, parking, bicycle route, and carriageway.



The P-indicator in the town centre is electronically controlled.

The large and very complex square is held together from facade to facade by one surface, unbroken by jumps in levels. Only the bus platforms are one step higher than the surrounding level.

The overall pattern of the surface is made by a square network of concrete paving stones. The carriageway, parking, pedestrian and public areas are paved with one type of concrete slabs. The required distinction between functions has been achieved by means of different sizes, colours, and surfaces.

The carriageway across the square is only delimited by drainage grooves. Pedestrian crossings are paved tracks breaking the pattern of the carriageway. On part of the carriageway parking lanes constitute natural transitions to the public areas.

Primary lighting on the square is by park lamps sited among the trees to give a soft filtered light. Secondary lighting is by low bollard lamps, mainly in the parking areas.

Across the public space and parking areas stretches a patterned planting. As with the furniture, it is governed by the square network of the surface pattern.

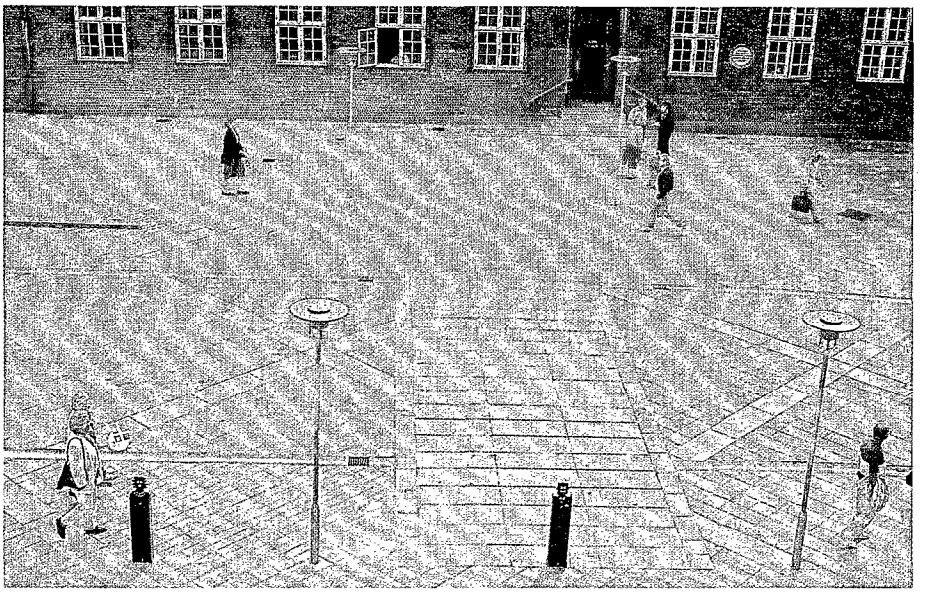
Road signs on the square are restricted to the required minimum and are mainly placed in low gallows so that they do not dominate the surroundings.

Benches and other street furniture are placed in groups and act as borders between the individual functions of the square. On the square there is, for example, an ornamental pond surrounded by benches and vegetation.

Results

Kolding municipality has succeeded in creating a beautiful and well co-ordinated open space in front of the old railway station.

No comparable measurements of traffic volumes and speeds before and after



Carriageway with pedestrian crossing.

Park lamps and trees are beautifully placed in relation to each other.

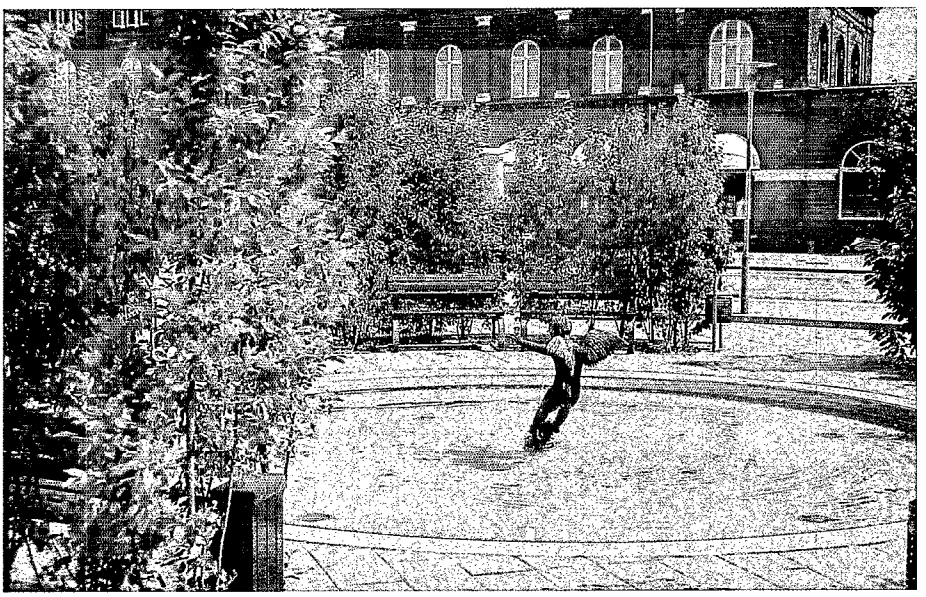
Signposting is discreet.

the conversion are available. There is no doubt, however, that there has been a reduction of both car speeds (due to the design and pavement of Jernbanegade and the station square) and traffic volume (due to the speed reduction and the change to two-way traffic in Fredericiagade).

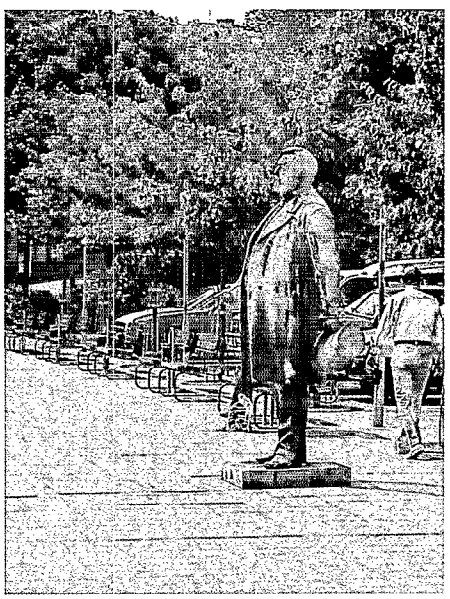
As regards traffic accidents one might have feared that because there was no difference in level between carriageways and open, public spaces, conflicts might have arisen between heavy and light road users. However, during the 2 years following the conversion there has been only one accident causing personal injury on the station square and none in Jernbanegade.

On the other hand the design of the square seems to make too heavy demands on some drivers' ability to take their bearings during parking and reversing as there have been several collisions with the tree-guards erected around the young trees.

A patterned planting keeps the functions of the square together.



This sitting group is sheltered but not isolated from the rest of the station square.



From his pedestal Chresten Berg has come down among the town inhabitants.

	Before	After
Car traffic	(1989)	
- Jernbanegade	12,400 vhl/24 hrs	-
Speed specified by signs	50 km/h	30 km/h
Mean speed/85% quantile at point, both directions		(1992)
- Banegårdspladsen	-	32/37 km/h
- Jernbanegade	-	37/44 km/h
Accidents, total	(1984-86)	(1990-91)
- Banegårdspladsen	-	1.5 accidents per year
- Jernbanegade	1.0 accidents per year	0.5 accidents per year
Accidents, personal injury		
- Banegårdspladsen	-	0.5 accidents per year
- Jernbanegade	-	None

Sources: Car traffic and accidents before: Kolding municipality. Speeds and accidents after: VDL.

Shopping Street in Hjørring

In Østergade in Hjørring traffic is now to a large degree governed on the terms of the light road users. The establishment of the first 350 m of a total of 750 m pedestrian street and 30 km/h streets was made financially feasible by the shopkeepers, who by their advance payment for a rented street area contributed considerably to the financing.

The Town

Hjørring is one of 15 regional centres in the county of North Jutland and with 24,000 inhabitants it is the second largest town north of the Lim Fiord. Located centrally in the Vendsyssel region it is a characteristic shopping centre for a large surrounding area which during the summer is further populated by many tourists.

Østergade, which runs east-west in the town centre, is one of the very busy shopping streets.

The Background

In 1986 pedestrian streets were established, as an experiment, in Strømgade and in Søndergade-Østergade between Svinget and Lollandsgade. Interview studies made in this connection demonstrated that a majority found it was a good idea to establish summer-time pedestrian streets, but also that (another) majority thought that traffic and parking conditions had deteriorated.

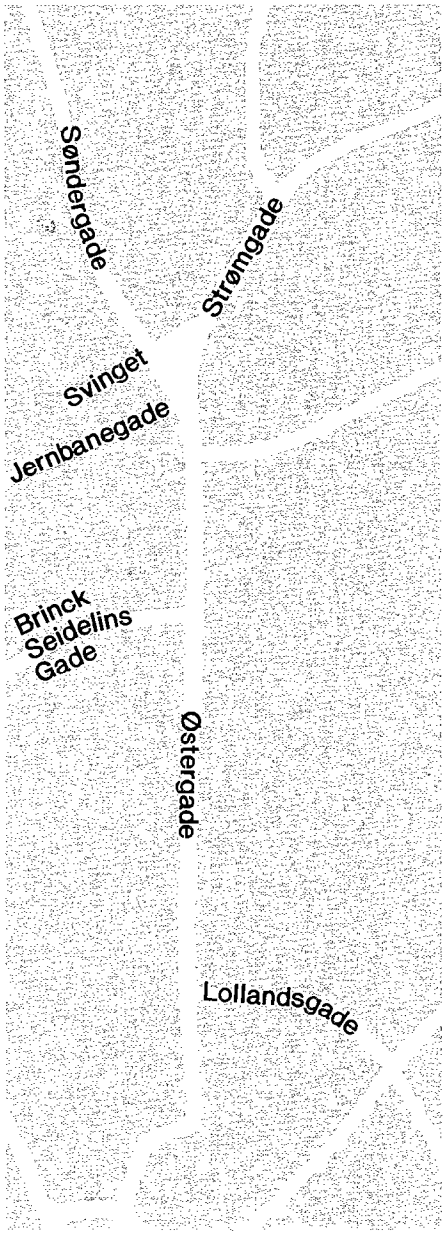
On the basis of this experiment the town council in 1987 passed a town-centre plan which defined Strømgade and Springvandspladsen as pedestrian streets. Østergade-Søndergade between Svinget and Lollandsgade was to be turned into a 30 km/h street designed so that it could be changed into a pedestrian street simply by signs, for example in the tourist season or during the Christmas shopping period.

In addition the plan included improvements of the ring roads around the town centre, which has caused a reduction of the traffic in Østergade.

Planning

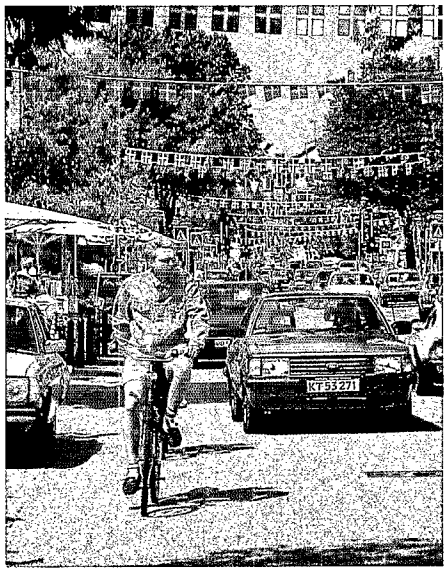
As the municipality could not fully finance the reconstruction, negotiations were initiated with the local chamber of commerce regarding co-financing. By the autumn of 1990 the result was that the shopkeepers would pay 40 per cent of the total costs, calculated as an advance payment of 10 years' rent for display, service, or parking areas in front of the shops.

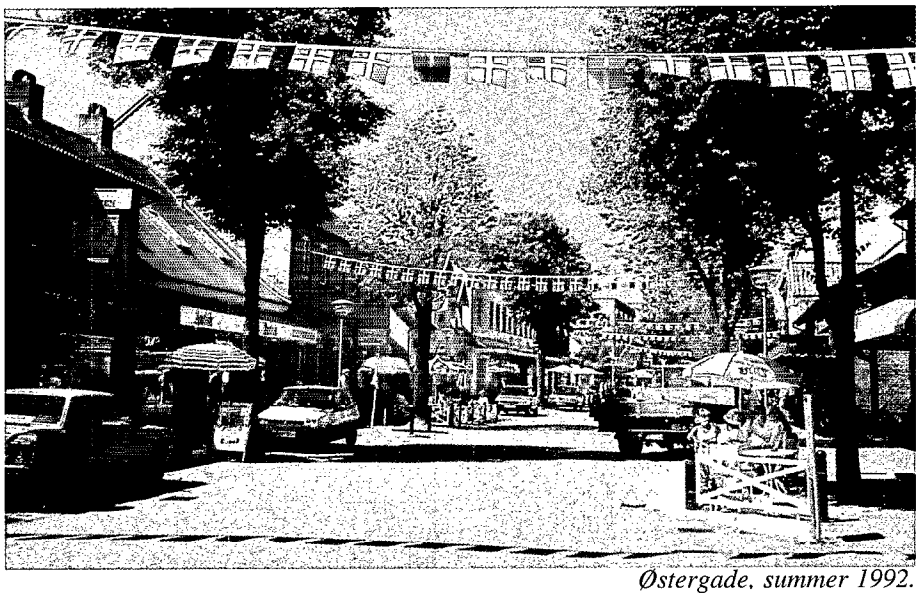
Road authority	Hjørring municipality
Project scope	
- 1st stage	350 m 30 km/h-street
- 2nd stage	200 m 30 km/h-street 200 m pedestrian street and square
Inaugural year	
- 1st stage	1991
- 2nd stage	1992
Costs	
- 1st stage	DKK 5 m



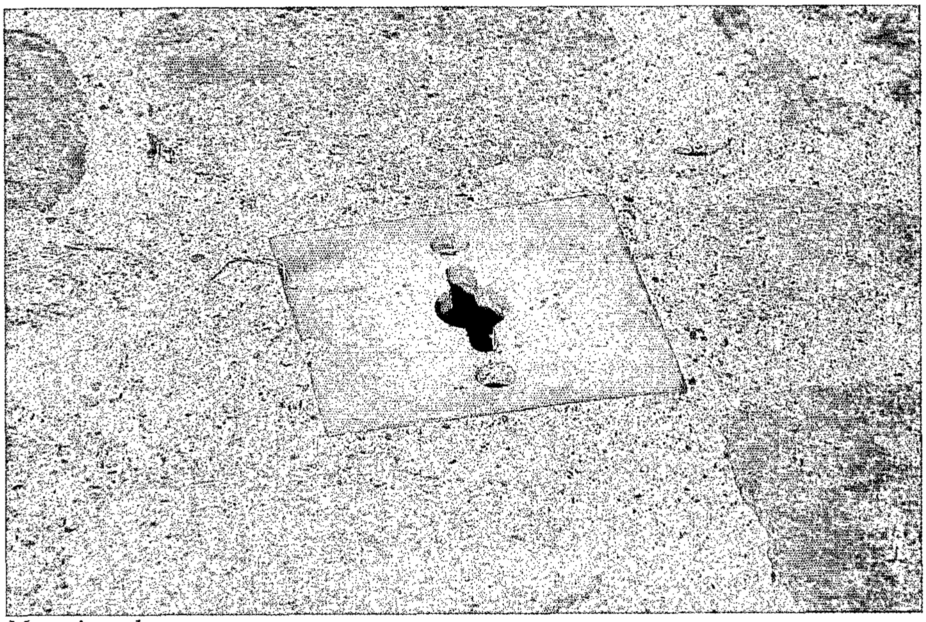
Østergade, 1900.

Østergade, winter 1991.

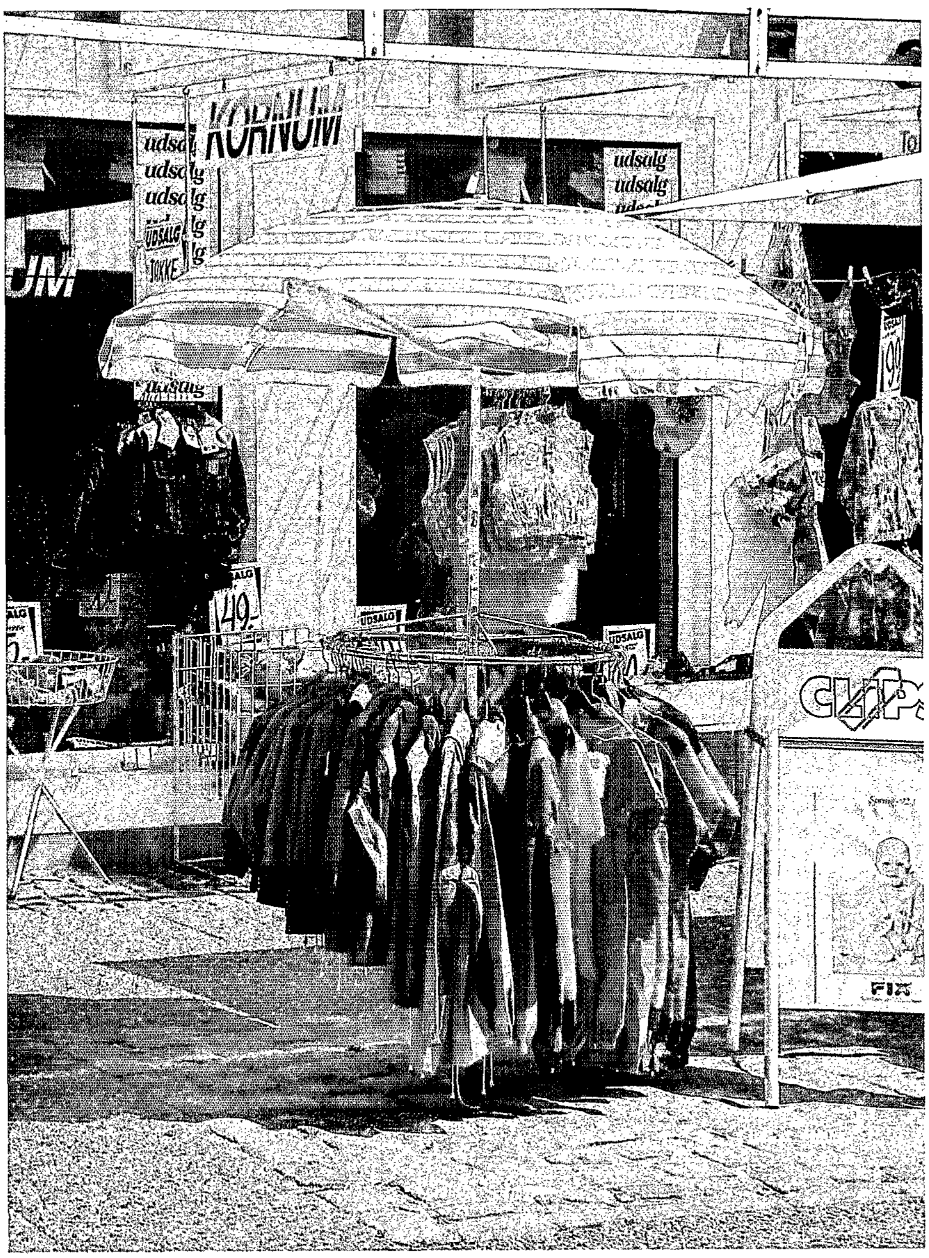




Østergade, summer 1992.



Mounting plate.



On the mounting plates e.g. clothes racks can be attached.

Simultaneously with the negotiations the municipality had prepared a proposal for the street design, and in 1991 the first section of Østergade, between Markedsgade and Br. Seidelinsgade, was converted to a 30 km/h street.

The second, and in this connection last, stage was implemented in the autumn of 1992. It includes a 30 km/h street in the remaining part of Østergade and Søndergade past the Springvandspladsen, plus a pedestrian street in Strømgade. Already now Strømgade functions as a pedestrian street, but with an ordinary asphalt surface which has temporarily been painted to emphasize the street function.

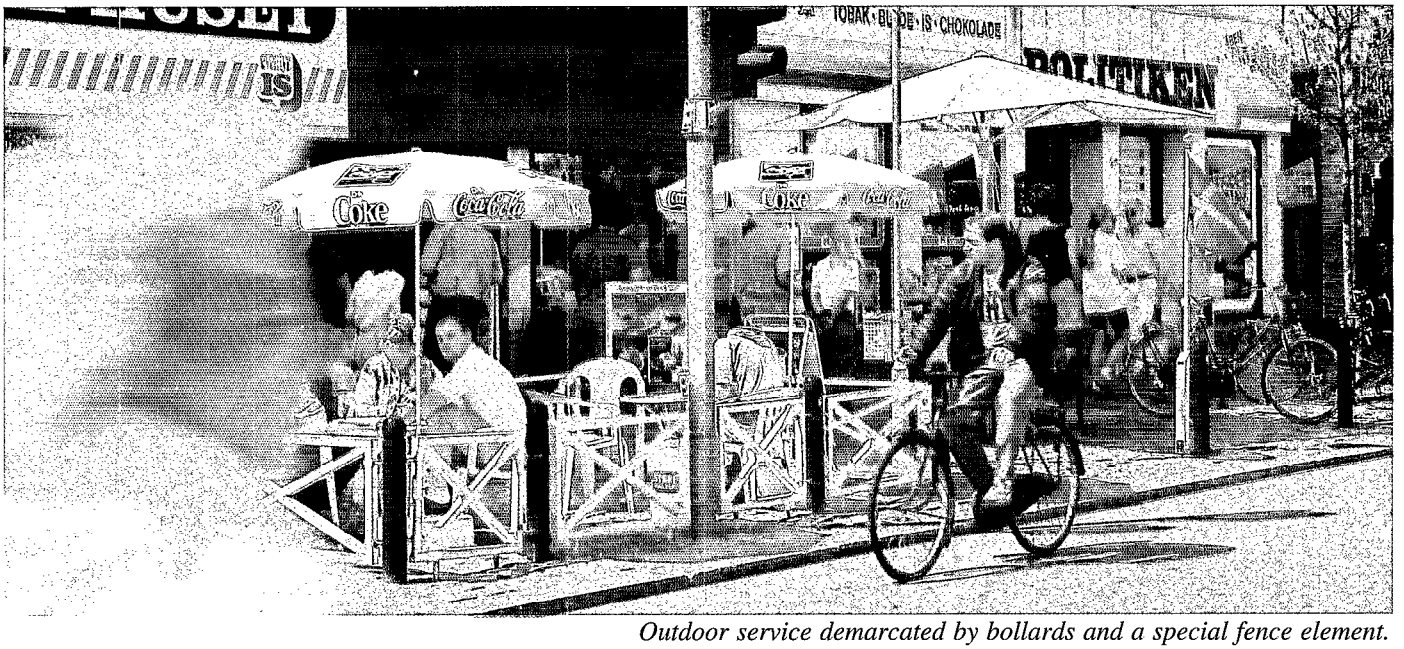
Design

Østergade is between 15 and 21 m wide and so is large enough for both light and heavy road users, and both leisure and trade.

At the conversion the street was divided into a number of bands with different functions. Nearest to the facade there is a narrow granite cobble ribbon which neutralizes the different house-front projections and which in certain cases can be utilized for displays by the shopkeepers. Next follows an approximately 2 m wide walking zone paved with slabs with exposed aggregate - and outside this there is a cobbled band of varying width which can be used for street furniture, lighting, plantings, displays, parking, etc. In the middle there is a 6 m carriageway, likewise paved, so that the whole street assumes a uniform style.

The chosen design means partly that kerb stones have been avoided, partly that visually handicapped people can move safely on the sidewalk areas.

Normal right-of-way rules apply on this section and road signs recommend



Outdoor service demarcated by bollards and a special fence element.

a speed of 30 km/h. Regular bus service runs through the stretch.

The fixed furniture includes old and some new trees, new lamps, and a limited number of road signs. Movable fixtures include bollards, benches, flowers, cycle racks, litter boxes, notice boards, clothes racks, and parasols.

All furniture and fixtures are bolted to two rows of mounting plates cast-in at a constant spacing in the cobbled band, and loose equipment is designed for easy attachment. This permits a very flexible use, where clothes racks can be removed outside opening hours, benches can be moved away for the winter, and the area can shift between display and parking.

Results

The conversion and the other changes of the town centre's traffic network, including the establishment of a ring road, have resulted in a very substantial reduction of the traffic intensity.

No speed measurements were performed before the conversion.

In an intersection and at a number of zebra crossings red paving has been utilized. Here, at Fynsgade, the zebra crossing is combined with a circular hump.

	Before	After
Car traffic	(1986)	
Before ring roads	12,000 vhl/24 hrs	-
	(1991)	
After ring roads	3,700 vhl/24 hrs	-
Speed specified by signs	50 km/h	30 km/h
Mean speed/85% quantile		(09.91)
at point, both directions	-	28/36 km/h
Accidents 1st stage	(1985-89)	(07.91-07.92)
- total	3.6 accidents per year	2.0 accidents per year
- involving personal injury	1.0 accidents per year	1.0 accidents per year

Sources: Hjørring municipality. Accidents: VDL.

Shopping Street in Vordingborg

The main shopping street in Vordingborg, Algade, has been converted from a one-way street to partly a pedestrian street, partly a 30 km/h street with commercial traffic allowed in both directions. The conversion has embellished the street and reduced car traffic volume and speeds considerably.

The Town

Vordingborg, the southernmost regional centre of Sealand, has 8,600 inhabitants. The town has a county regional hospital, a barracks, a harbour, and some industry, but the town is primarily a trading town, with Algade being the most important shopping street.

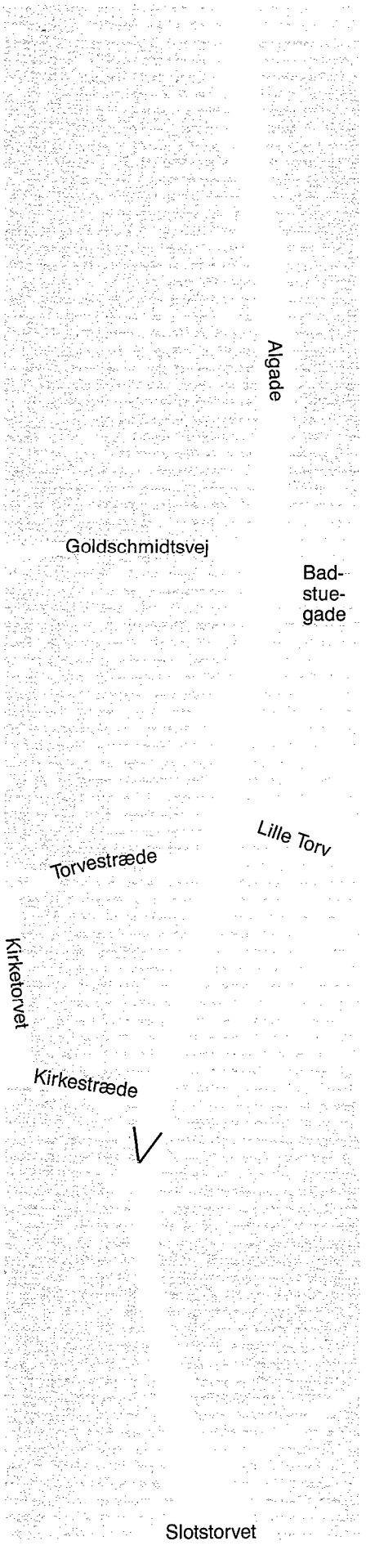
Road authority	Vordingborg municipality
Project scope	700 m 30 km/h-street and pedestrian street, 2 traffic circles
Inaugural year	1991
Costs	DKK 5.0 m

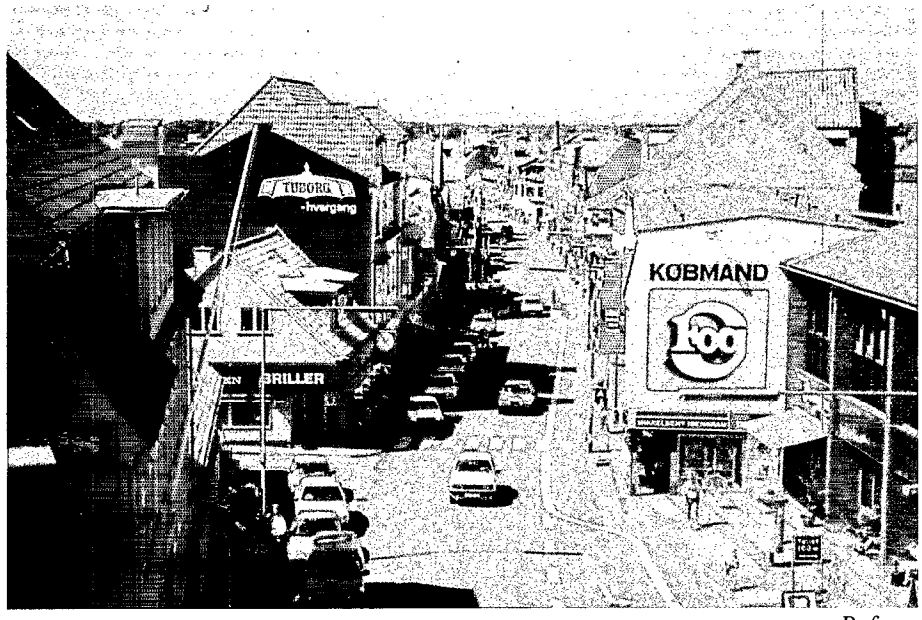
The Background

The growing traffic in Algade through the 1980s stimulated a strong wish to improve the shopping atmosphere in the street. With this in mind an experiment was started in 1988 introducing one-way car traffic but still with two-way cycling. The street design included siting of concrete rings, humps, and road marking for cycle tracks on both sides of the road.

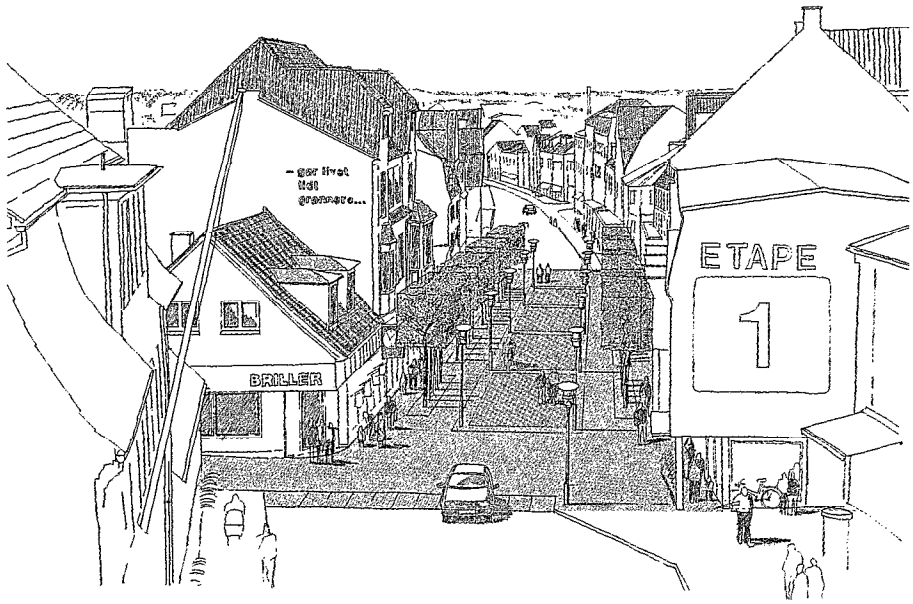
The experiment caused intense criticism both of the function and appearance of the street and led to a requirement for further calming and some embellishment of the street.

During the experiment there was one-way car traffic.

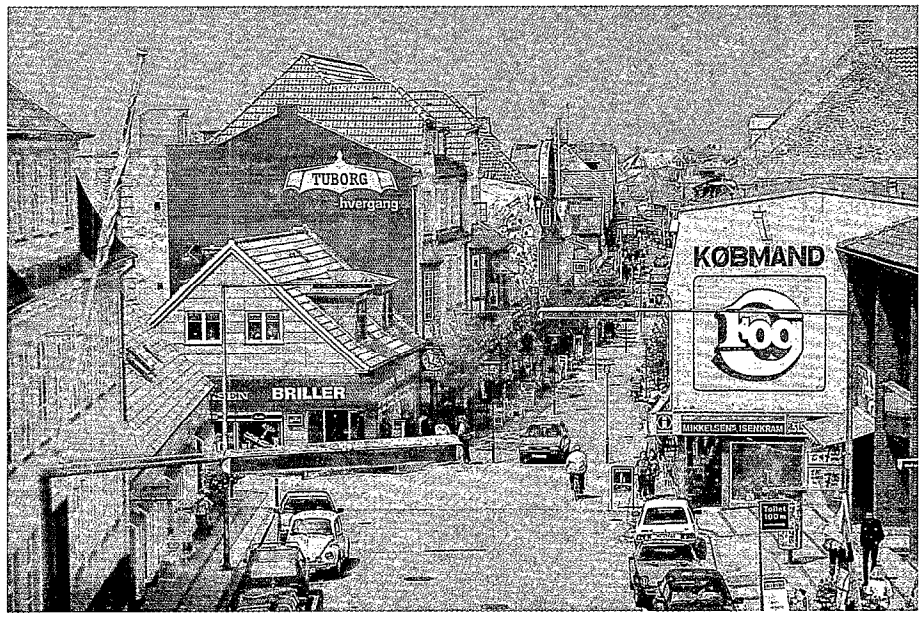




Before.



The project.



After.

At the lamp posts two cars cannot pass each other.

Planning

A working group was established with politicians, technicians, consultants, and representatives of the local chamber of commerce, the Algade committee. On the committee's recommendation and based on an outline design it was decided, in 1989, to convert Algade to a two-way 30 km/h street on a 700 m stretch from Slotstorvet to Boulevarden.

It was decided that the street was to be designed so that it could later be changed into a proper pedestrian street only by changing the road signs. In addition the design would allow for a step-wise conversion as it was not expected that all 700 m could be rebuilt at once.

Conversion

Until now the conversion has taken place in two stages, in 1990 and in 1991.

The first stage included 4 sections, one at each end of the street and two in-between. On the rebuilt sections parking is not allowed. The non-converted sections were marked as silent roads and provided with roadside parking alternately on the sides.

Stage 2 was an extension of one of the middle sections including a conversion of the two narrow streets of Kirkestræde and Torvestræde. This has made it possible in 1992 to convert the stretch between the two streets into a pedestrian street with only commercial traffic allowed as the through car traffic passes by via the two streets and Kirketorvet.

In this connection good parking facilities have been established, with rear access to most shops.

Before the conversion 150 buses passed through the street every day. These services now run on the parallel streets of Valdemarsgade-Voldgade.

Design

The converted sections have an only 3.6 m wide carriageway along the centre line, marked by lamp posts. Between a pair of lamp posts a car and a bicycle may pass each other, but not two cars. However, there is ample space for passing on the sections between the lamp posts.

At each end of Algade there is a little traffic circle which gives access to the street. In the central island of the circle there is a little bronze sculpture: an ancient town gate in miniature placed on a granite base.

The traffic circles contribute to the reduction of car speeds and permit cars to set down passengers and drive off again.

Street Surfaces

The converted sections are all paved from facade to facade with the same type of concrete paving slabs with embedded, exposed granite. The slabs are light grey on pedestrian areas, reddish on the carriageway, and blue-black at special facilities. In addition, the carriageway is bordered by a granite cobble band.

In connection with the project extensive new pipe was laid. In return it has been agreed with the utility boards that there will be no street excavations for 5 years after the conversion.

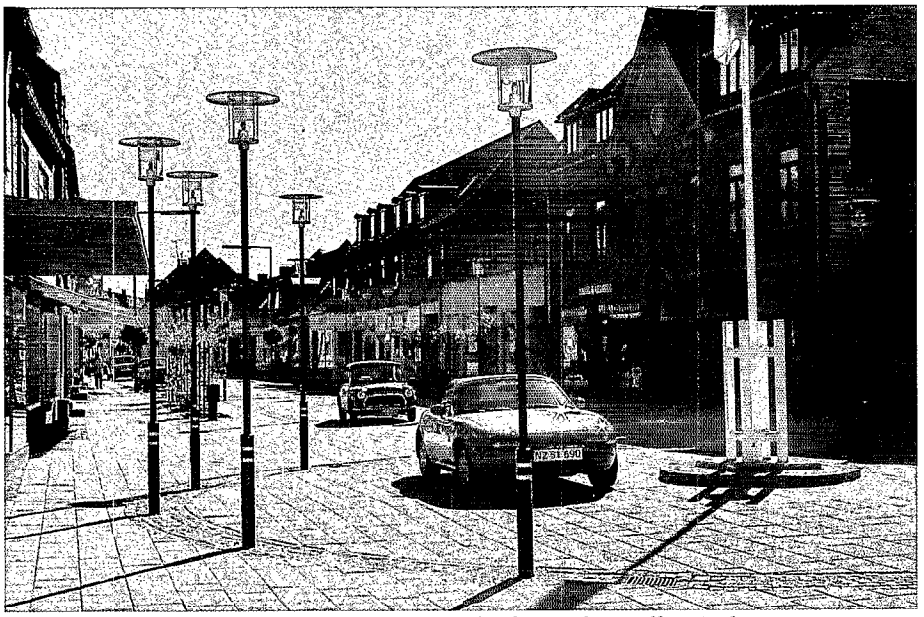
Plantings

The street space has been structured by the planting of small-leaved lime trees which in time will have to be cut as trunk hedgerows. The street curvature has been underlined by planting the trees in a single row at the outside line of the curve, and on both sides on the straight stretches.

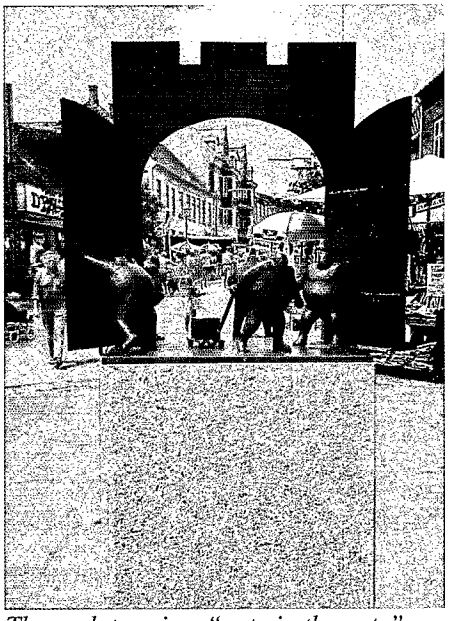
Great care was devoted to the planting of the trees. Much soil has been replaced. The roots are protected from the district heating pipes by means of steel plates and insulation and special tree supports have been designed which are not carried into the ground. On average, the planting of each tree has cost DKK 15,000, of which only about DKK 2,000 is the cost of the tree.

In the summer season these trees are supplemented by hanging flowerpots planted with geraniums.

In the second stage, creeper flower stands were provided of the same design as the tree supports.



At each end of the street there is a gate in the form of a traffic circle.



The sculpture is a "gate in the gate".

Street Furniture

Generally, great importance has been attached to achieving the overall coherence of the individual elements. The majority of the new street furniture, e.g. bollards, benches, and litter-boxes, are part of the same design collection.

The bollards and the lamp posts delimit the width of the carriageway. To prevent cars from bumping into them they are provided with clear reflector bands.

Results

During the one-way experiment about 4,000 cars drove through the street every day. This number did not change much during the first months after the conversion when about 4,000 cars drove through in the two directions together. Car speeds were not reduced much in the beginning either.

Over time both the number of cars and their speed have fallen. The pedestrians have slowly taken possession of the street space and a growing number of drivers now choose other routes, or drive more slowly than before. With the implementation of the second stage the daily traffic thus dropped to about 2,700 cars, and the number seems to have decreased further after the conversion into a pedestrian zone with only commercial traffic allowed.

A very important result of the conversion is that the street has become prettier. However, this also means that the redesigned sections stand out in sharp contrast to the stretches that have not yet been converted.

The shopkeepers' and the inhabitants' reactions towards the municipality are generally positive. And it is characteristic that satisfaction has grown concurrently with the implementation.

Further Initiatives

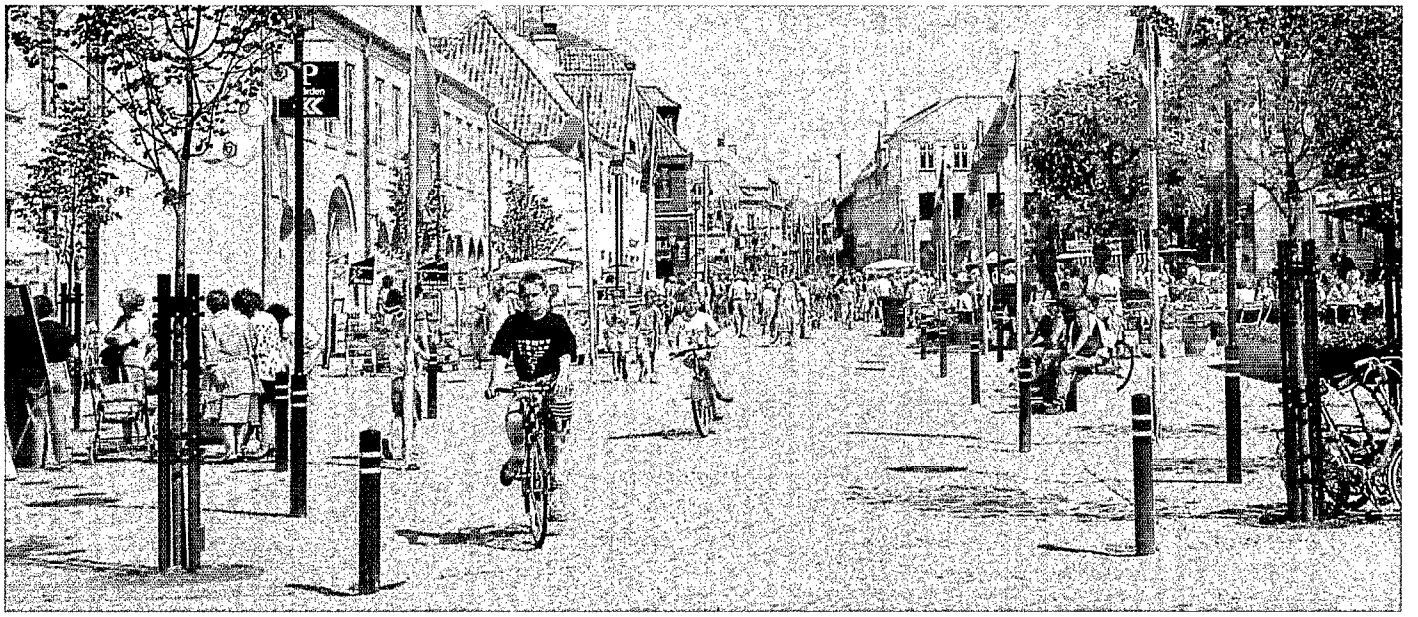
In the longer term it is the intention to fill in the "gaps" of the conversion. In addition there are plans to include Badstuegade, which connects Algade with the town hall and a shopping centre, in order to create a passage like a square.

Navigational orientation point.

	Before	After
	(1990)	(1992)
Car traffic	4,000 vhl/24 hrs	2,700 vhl/24 hrs
Speed specified by signs	30 km/h	30 km/h/15 km/h
Mean speed/85% quantile at point, both directions	(1989)	(1992)
Kirkestræde	34 km/h	35 km/h
Lille Torv	29 km/h	25 km/h
Accidents	(1983-87)	(1.9.91-10.8.92)
- total	7.4 accidents per year	7.0 accidents per year
- involving personal injury	1.6 accidents per year	1.1 accidents per year

Source: Vordingborg municipality.

Shopping street in Assens



As part of the "More beautiful streets" project in which the Road Directorate in co-operation with local authorities carry out traffic calming projects with a particular emphasis on the visual environment, the main street in Assens has been converted to a 20 km/h street.

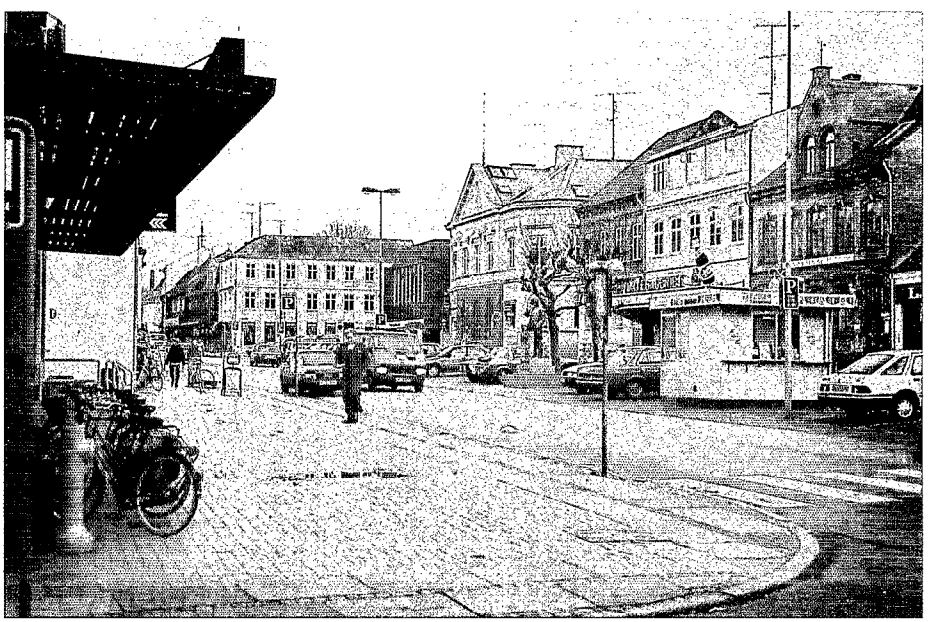
The Town

Assens, situated in western Funen on the Little Belt coastline, is one of the 13 regional centres on the island and has 5,600 inhabitants.

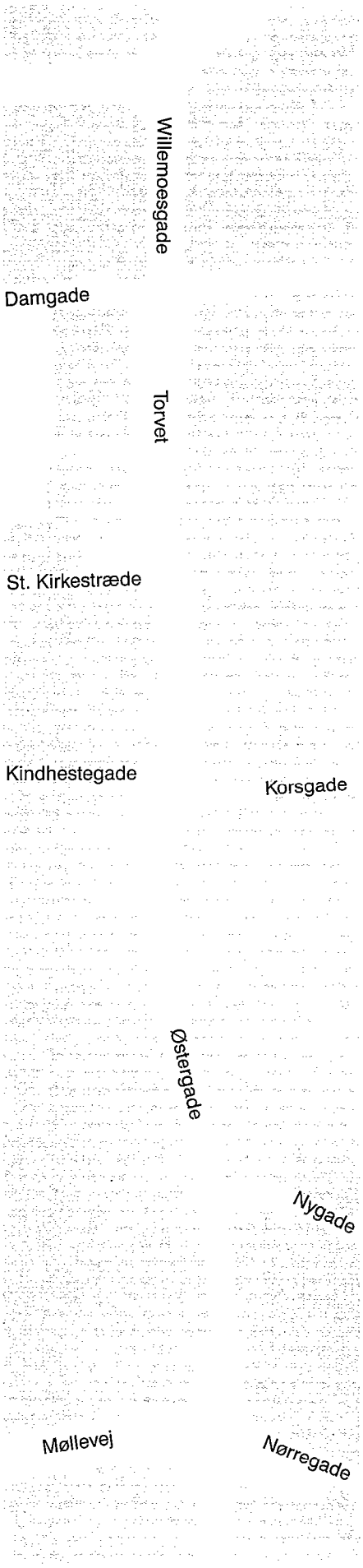
The highway starts at the harbour and runs through the town centre (Willemoesgade-Torvet-Østergade), past the county regional hospital, through some fairly recent residential areas, and towards Odense. The way through the whole town is approximately 2 km and the stretch through the town centre about 600 m. Most shops are situated in Østergade, which prior to the conversion had an annual traffic per day of about 5,000 cars.

The conversion project covers the 600 m through the town centre *(47)*.The first stage, Willemoesgade-Torvet, i.e. the westernmost 200 m, was inaugurated on 3 July, 1992. The second stage will be the conversion of the remaining part of Østergade up to Nygade/Nørregade, and the third stage will be the establishment of a rounda-

Road authority	Assens municipality
Project scope	
- 1st stage	200 m 20 km/h-street
- 2nd stage	300 m 20 km/h-street
- 3rd stage	Roundabout
Inaugural year	
- 1st stage	1992
- 2nd stage	1993
Costs	
- 1st stage	DKK 3.8 m
- 2nd stage	DKK 4.5 m estimated



The Town Square in 1990.



bout in the Østergade/Nørregade intersection. Completion of phase 2 is expected by June 1993.

The Background

The growing interest in involving the visual environment as an important factor in the traffic planning has manifested itself in different initiatives started by the Road Directorate.

Correspondingly, as an important part of the Road Standards series on "Urban Traffic Areas", volume 10: "The Visual Environment" has been published while at the same time demonstration projects have been started in the towns of Assens, Skagen, and Hobro.

The main objective of the demo-projects is to create examples of streets in which the visual environment has been given top priority, but also to test alternative ways of financing, and various forms of organization and communication.

The three towns were chosen among others on the basis of

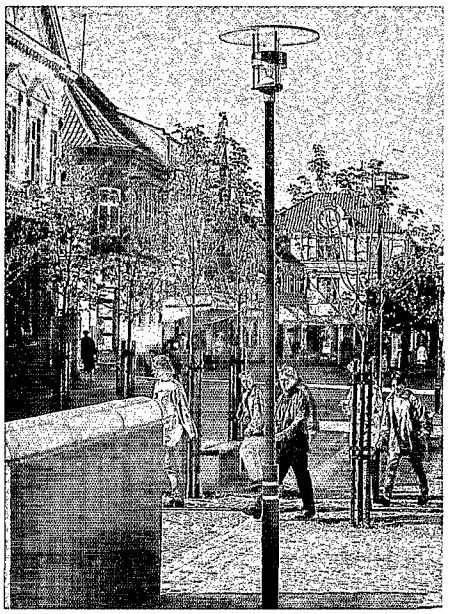
- the existing street picture
- the towns' wishes for changes
- the possibility of creating more beautiful town spaces
- the need to prevent accidents
- wishes for environmental changes
- the possibility of implementing the conversion simultaneously with other construction works
- the possibility of testing the co-operation with landowners and shopkeepers
- the possibility of untraditional ways of financing

Planning

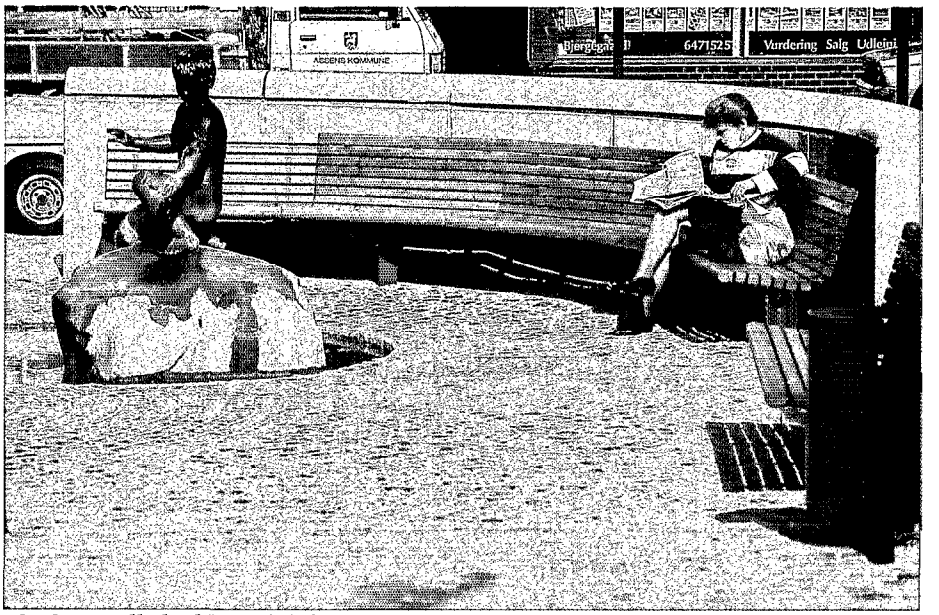
In 1990 an agreement was made between the Road Directorate and Assens municipality about the appointment of a working party with representatives from the Road Directorate, the county, the municipality, the police, the local chamber of commerce, and the local industrial council. Led by the chairman of the municipal technical committee this group has managed the working process with professional and practical assistance from the municipal technical administration, the Road Directorate, and a traffic planning consultant.

As a basis for the design of the main street an overall traffic reorganization plan was prepared for Assens. The plan specifies, among other things, that the previous through-traffic along Willemoesgade-Østergade must use other roads in future, mainly the north and south ring roads.

The patterned planting provides shelter.



The new lighting.



The low wall shields and defines space.

In addition, a time schedule for project progress from conception to implementation was prepared. The planning process was estimated to be 8 months but in effect lasted about one year.

Design

The main aesthetic points in the design of the three demo-projects have been

- to create a street space whose pavement and furniture are as beautiful as many of the house fronts facing the street
- to reduce the street space to a size which is in harmony with the other town streets
- to improve unsightly town spaces, e.g. by involving the surroundings in the project
- to strengthen existing qualities and characteristics

In Assens, Østergade has been rebuilt from facade to facade and converted to a 20 km/h, two-way street where pedestrians have the right of way. The new cross-section consists of a 4.5 m wide carriageway edged by 0.6 m wide stone-set bands in each side. These stone bands link the whole street together and are only broken by the squares. On each side of the carriageway there is a 1.8 m wide area which is used, alternately, for parking and street equipment, plus a sidewalk area. The carriageway is granite-set in arched bond and pedestrian areas are paved with concrete flags in a light colour.

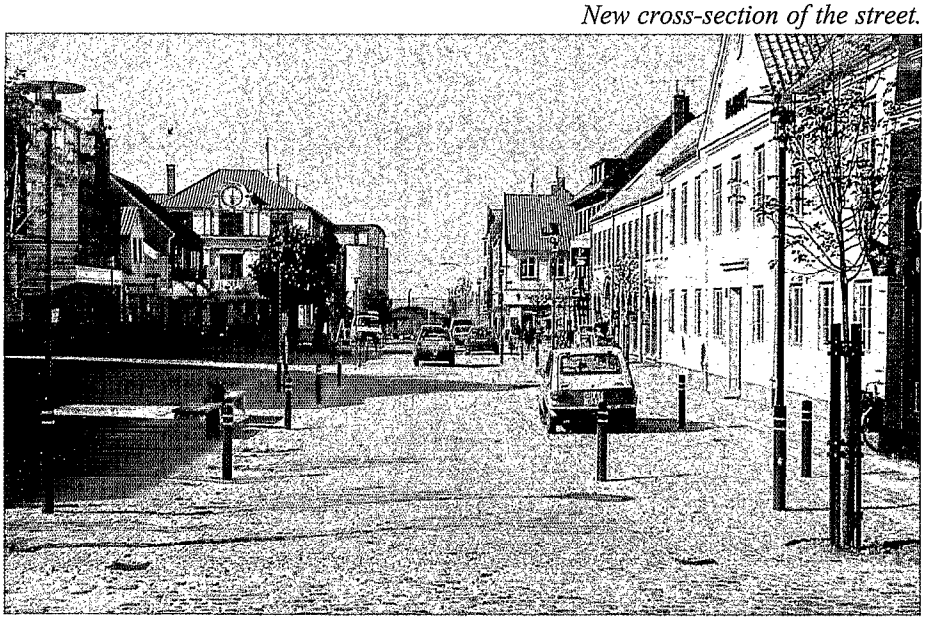
The former lamp-posts have been replaced by the far smaller "Albertslund" lamps.

To maintain the street's provincial character trees have been planted and creeper flower stands placed spot-wise. One of the advantages of the creeper flower stands is that they can be combined with planting hole depths of only 60 cm, which makes it easier to avoid collisions with ground utility pipes.

The Square, where Store Kirkestræde joins Østergade, has been rebuilt so that it now forms one big town space made up of three rectangular, granite-paved areas. The two former open spaces, the public space at the county savings bank and the large area at the square have been connected by means of a 1.2 m high wall which also acts as a shield against driving traffic on Store Kirkestræde and Østergade.

On the square the width of the carriageway has been limited to 3.6 m with edging stone-set bands of 0.6 m in both sides. This width, which makes it possible for a car and a cyclist to pass each

New cross-section of the street.



other but requires that cars give way for oncoming cars, ensures a particularly low speed on the square.

The square is paved with granite. The central public area is granite sets in peacock bond and the carriageway in arched bond. The approach to the square is cobbled.

The planting is a patterned planting of lime with openings determined by the in-ground utility pipes, by the views of the house fronts, sight lines, and a wish for a spacious impression. At the same time the planting has been laid out to provide shelter against the strong draughts coming up through Willemoesgade from the harbour to the west.

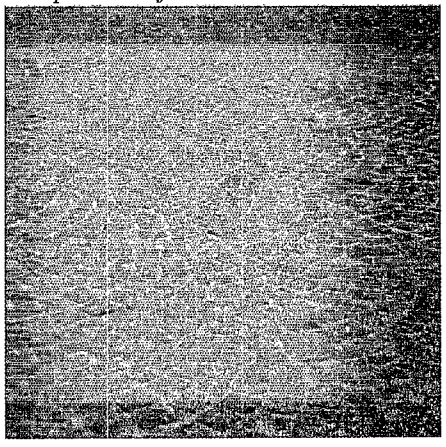
As previously, the statue of one of the famous sons of the town, member of parliament Klaus Berntsen, adorns the square.

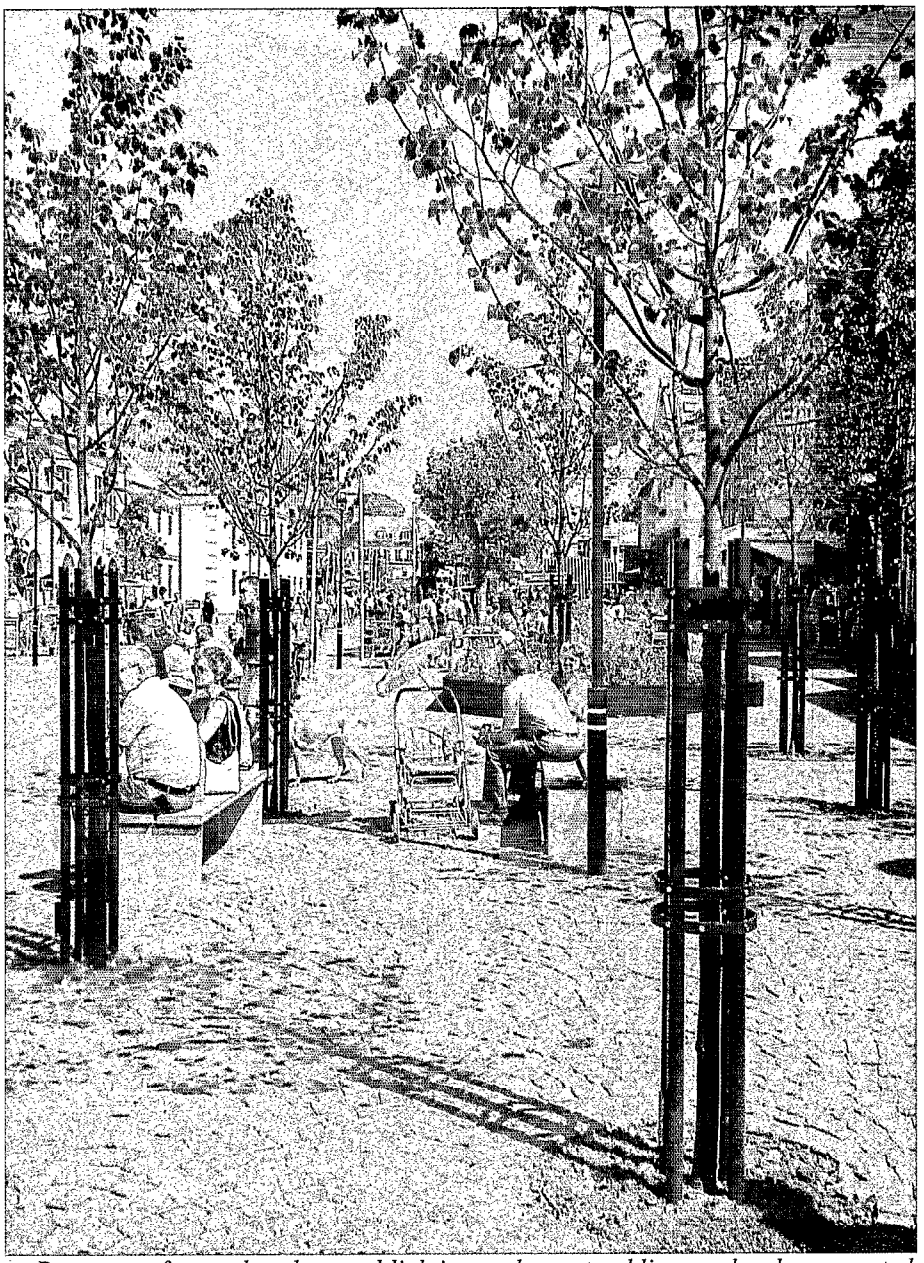
Results

The conversion is still so new that it has been impossible to conduct follow-up studies. A number of before-investigations showed *(70)* that

- the traffic in Assens is generally moderate
- there is considerable traffic in the intersection Østergade/Nørregade
- it would be possible to redirect some through traffic away from Østergade
- there are many cyclists
- there are sufficient parking facilities

The paved surface.





By means of trees, benches, and lighting a pleasant public area has been created.

	Before	After
Car traffic	(1989)	
- Willemoesgade	3,200 vhl/24 hrs	-
- Østergade	4,000-5,600 vhl/24 hrs	-
Speed specified by signs	50 km/h	20 km/h
Accidents	(1984-88)	
- total	5.6 accidents per year	-
- involving personal injury	2.0 accidents per year	-

Source: SSV.

Town Street in Herlev

In Herlev a traffic-dominated town street in an area without any special characteristic unity has been converted to a harmonious town space in which the ancient church and the village pond also have been incorporated as significant elements.

The Town

Herlev is a suburb of Copenhagen, situated about 10 km from the city centre on the highway to Frederikssund. Herlev has 27,000 inhabitants.

Part of the town street called Herlev Bygade follows the former alignment of the Frederikssund highway, from before it was given a straighter route through the town.

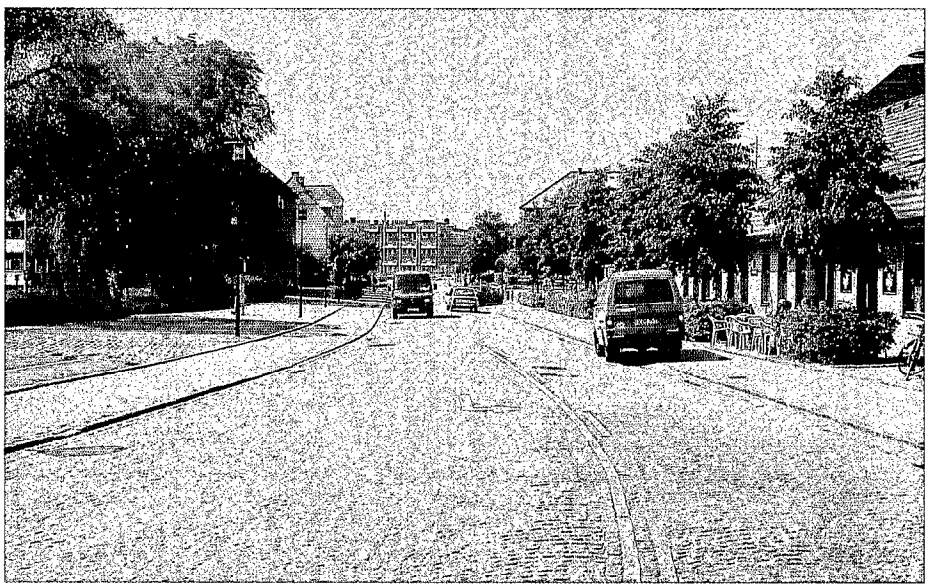
Road authority	Herlev municipality
Project scope	Conversion of 400 m road incl. adjoining areas
Inaugural year	1988
Costs	DKK 35 m

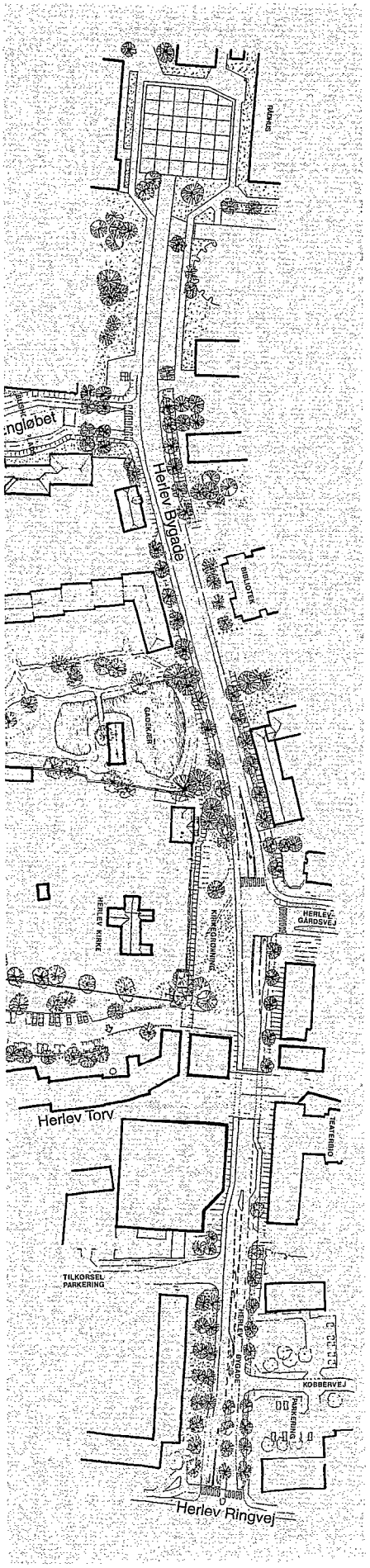
The Background

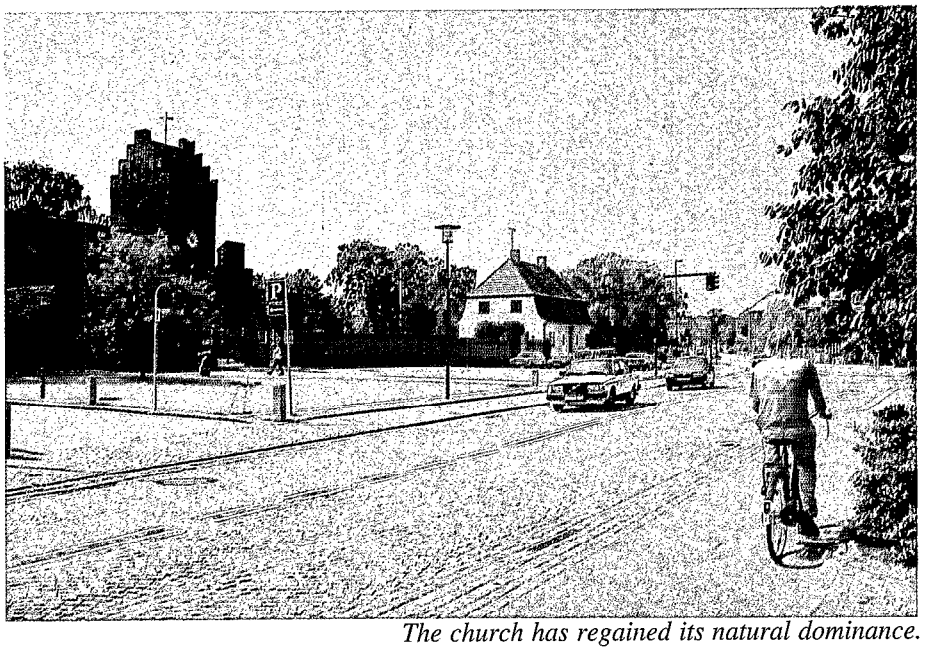
Herlev town centre is constituted around the north-south pedestrian street of Herlev Torv (i.e. "the square") and the east-west orientated Herlev Bygade, which is both the access to the parking facilities of the centre, and exit road for residential areas north of the road.

The shops around the square and the parking facilities behind them were established during the 1960s and 70s, but a finishing touch was still lacking to the north, where Herlev Bygade was both visually chaotic and characterized by heavy traffic and parking.

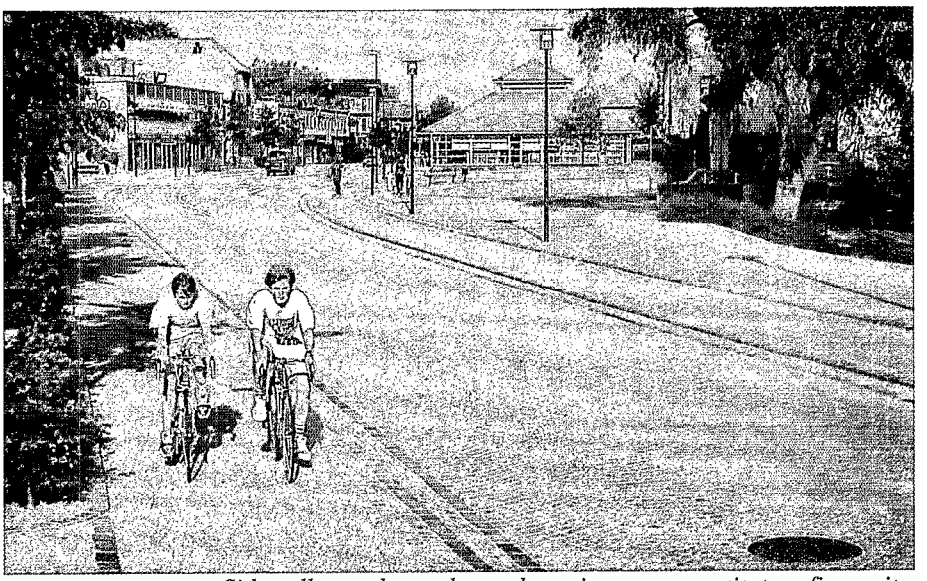
Old and new plantings supplement each other.







The church has regained its natural dominance.



Sidewalks, cycle tracks, and carriageway constitute a fine unity.

Planning

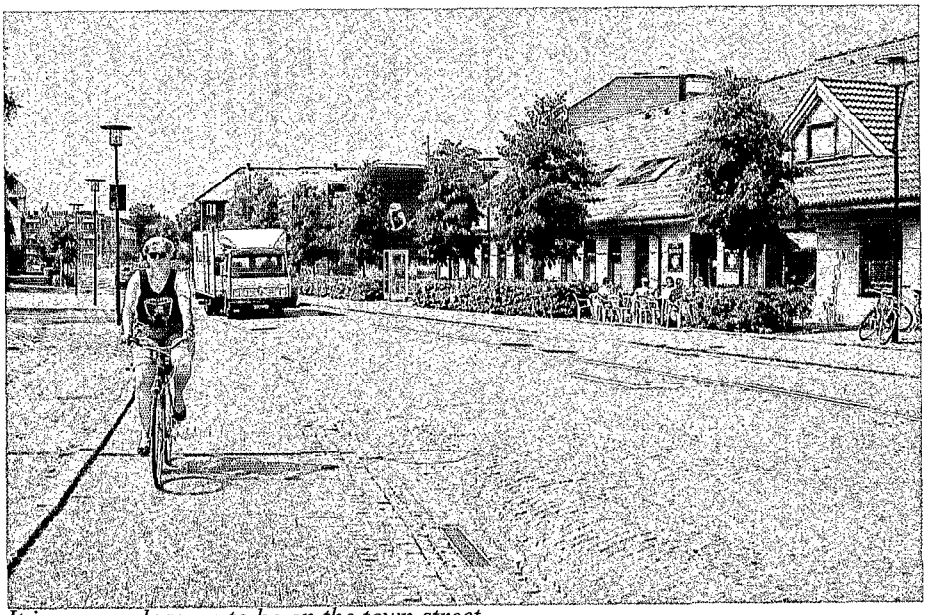
In 1984 the local authorities invited conceptual designs for a competition about the future of Herlev Bygade. In 1986, after adjustments, the winning project formed the basis for further work. A folder about the conversion was distributed to the town inhabitants and since then urban renewal work has proceeded as planned.

Design

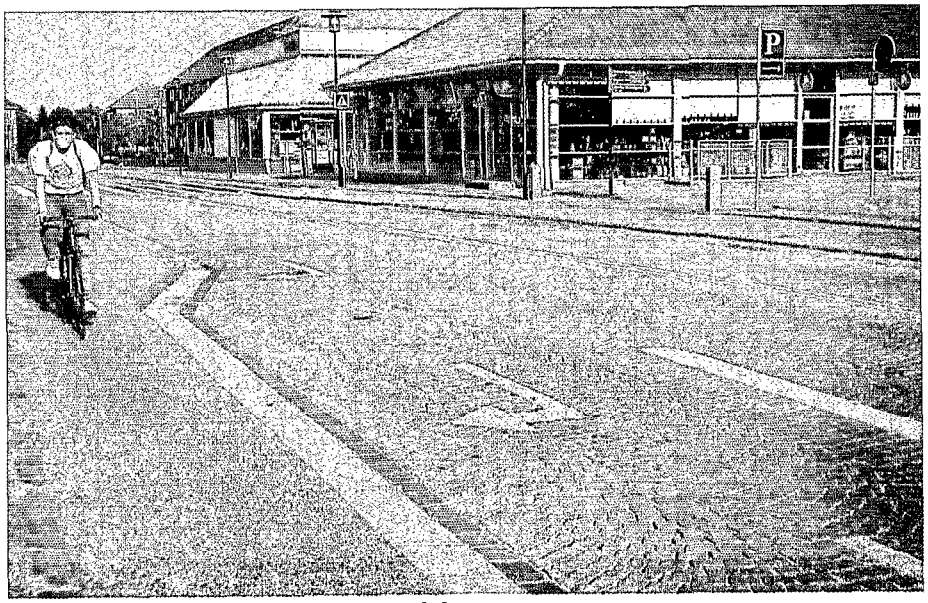
The area has been renewed both as regards houses, landscaping, and traffic.

At the approaches to the central area it has been attempted to make plantings and buildings function as a kind of gates to the area. Additionally, the northern perimeter has become visually better defined and more urban by the addition of new buildings and supplementary plantings.

In return the area south of the Bygade and west of the square has been given a more park-like character. The village pond has been enlarged, and a new terraced landscape stretches down to it from the Bygade.



It is now a pleasure to be on the town street.



Roadway marking is in white paving slabs -

- the zebra crossings as well.

In former times the little village church held a commanding position on the hilltop. The new landscaping around it has recreated the green hill, and the church has now regained its natural dominance.

The carriageway of the Bygade has been narrowed to 6 m and the parking bays have gone. The narrowness is underlined by a new pavillion on the corner of the square.

There are cycle tracks in both roadsides, in some places separated from the sidewalk by a row of trees.

The paved surfaces have been chosen with great care and are beautifully laid. The carriageway is granite-set and bordered by darker cobbles, while the cycle tracks and sidewalks are paved with 30 x 30 cm concrete slabs with embedded, exposed granite.

Road marking (zebra crossings, arrows etc.) has not been made with white paint but with concrete paving stones of the same size as the granite sets.

In connection with the conversion of Bygaden a special design programme has been developed. Benches, litter boxes, road signs etc. thus have a common artistic expression and appear in characteristic blue and green colours.

The church is again a characteristic part of the town scene.

Results

To ease the access to the centre the possibility of entering Herlev Bygade from Ring 3 was improved in connection with the scheme. This has caused a traffic increase in the eastern end of Bygade and an almost equal reduction in the western end.

The conversion has created a harmonious urban and traffic environment which the inhabitants, according to statements to the municipality, have welcomed.

Further Initiatives

In the summer of 1992 the Bygade was extended the last bit of the way to Herlev town hall, with a beautiful rounding-off to the whole project. The design of the last section follows the principles of the first phase, only supplemented by parking at right angles to the north side of the street.

The street runs to the town hall entrance square which is laid out as one big geometric square divided into smaller ones. The surface is made of light-coloured, square, concrete paving slabs with embedded, exposed granite, bordered by granite flags.

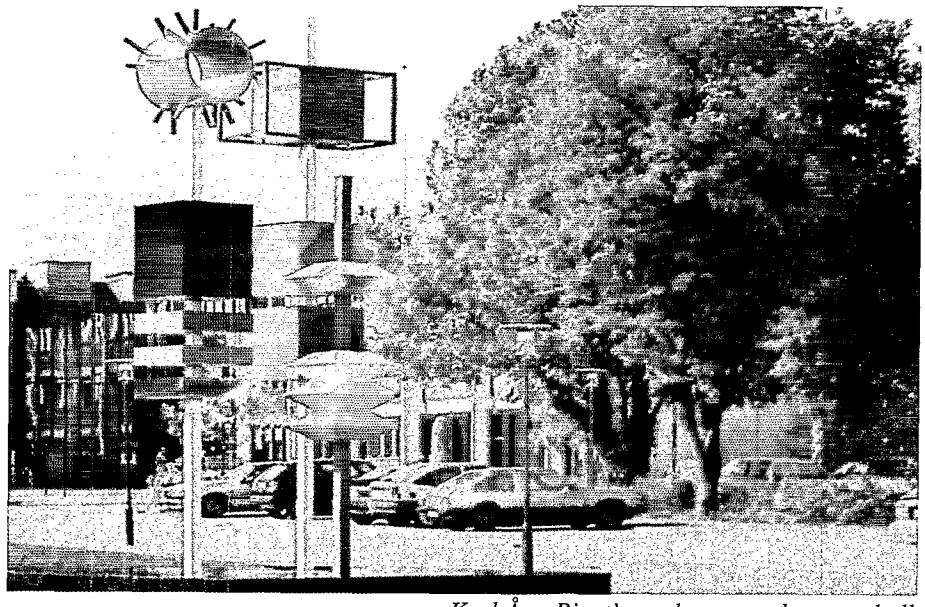
In the east and south sides of the square, parking bays are incorporated into the square network of the pavement.

The existing vegetation of the area has been supplemented by new groups of trees, beech brush, and ivy as ground cover.

A sculpture by Karl Åge Riget has been erected where Engløbet intersects the Bygade. A wall relief by the same artist is placed at the town hall's main door so that it functions as an invitation when people approach the entrance square.

In connection with the conversion a special design programme has been developed.

The intersection between Herlev Square and Bygaden.

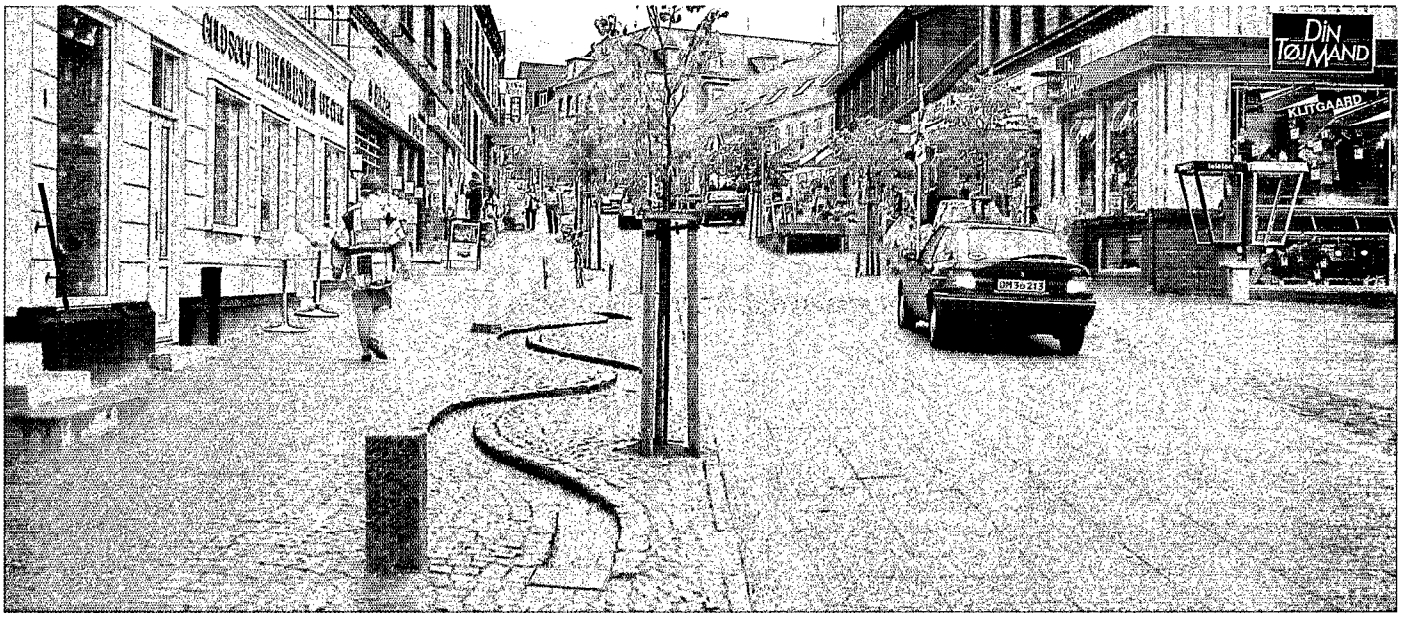


Karl Åge Riget's sculpture at the town hall.

	Before	After
Car traffic, rush hour		
- Western end	540 vhl/h	390 vhl/h
- Eastern end	440 vhl/h	550 vhl/h
Speed specified by signs	50 km/h	50 km/h
Mean speed at point	-	35 km/h
Accidents	(1982-86)	(06.89-06.92)
- total	5.2 accidents per year	2.3 accidents per year
- involving personal injury	2.6 accidents per year	1.3 accidents per year

Sources: Herlev municipality. Accidents after: VDL.

Shopping Street in Hadsund



The previously heavily trafficked Storegade in Hadsund has been given new pavement, plantings, and lighting - plus a streamlet as an extra characteristic element.

The Town

Hadsund, with 4,700 inhabitants, is one of the 15 regional centres in the county of Northern Jutland. It is situated where the highway between Aalborg and Randers crosses Mariager Fiord, mainly on the northern side of the fiord.

The Background

Storegade, which is the central shopping street in Hadsund, was previously part of the east-west going road from Hobro, through Hadsund, and onwards towards Als and thus the coast.

The street is characterized by Hadsund's location in a very hilly landscape, inasmuch as it falls steeply towards the highway of Himmerlandsgade.

Over the years, the car traffic in the street and its very mixed functions, not to mention the gradient, gave rise to a growing wish for changes.

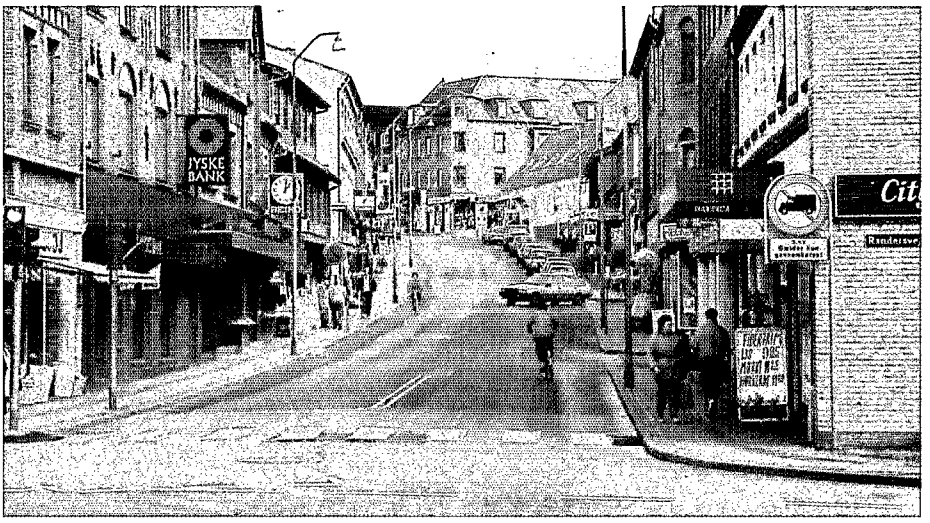
Planning

According to a traffic calming plan from the mid-1980s Storegade was to be declassified to local street status and the through-traffic to be channelled via other routes.

Road authority	Hadsund municipality
Project scope	300 m 30 km/h-street
Inaugural year	1990
Costs	DKK 3.3 m

In 1988, in accordance both with the wishes of the shopkeepers and with the traffic calming plan, the town council decided to convert Storegade to a 30 km/h street. Representatives from the local chamber of commerce and residents were involved in the planning process, which was of a fairly short duration.

The first stage of the conversion was implemented in the autumn of 1988 and the following phases in 1989. All were



Storegade before the conversion.

collectively inaugurated in the spring of 1990.

The total costs of the conversion were DKK 3.3m - of which DKK 0.5m was paid by the shopkeepers of the street and about DKK 150,000 were collected from private donors.

Design

The conversion has been carried out on the 300 m stretch between Himmerlandsgade and Østergade. The new cross-section of the road comprises

- an adjustment zone
- a 2-2.5 m wide sidewalk
- a 2.5-4.5 m wide service ribbon
- a 4-4.5 m wide carriageway
- a 1 m wide service band
- a 2-2.5 m wide sidewalk
- an adjustment zone

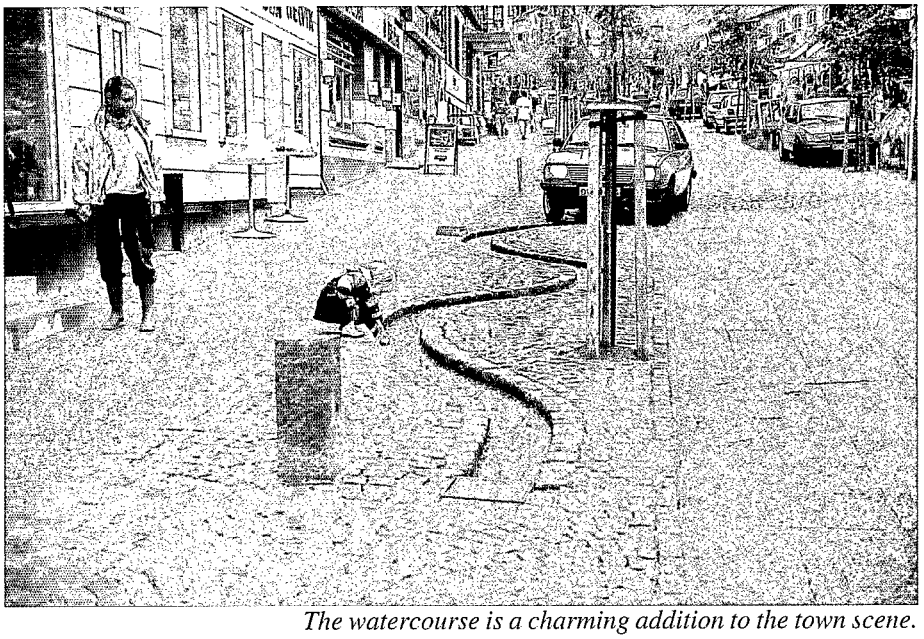
The broad, stone-set service ribbon is used for display, parking, lighting, and plantings, and also for a little streamlet which winds its way down through the street, disappearing and emerging again between the cobbles. During its course the water runs through some small basins and ends in a larger basin at Himmerlandsgade.

The lighting provided is "Albertslund" lamps.

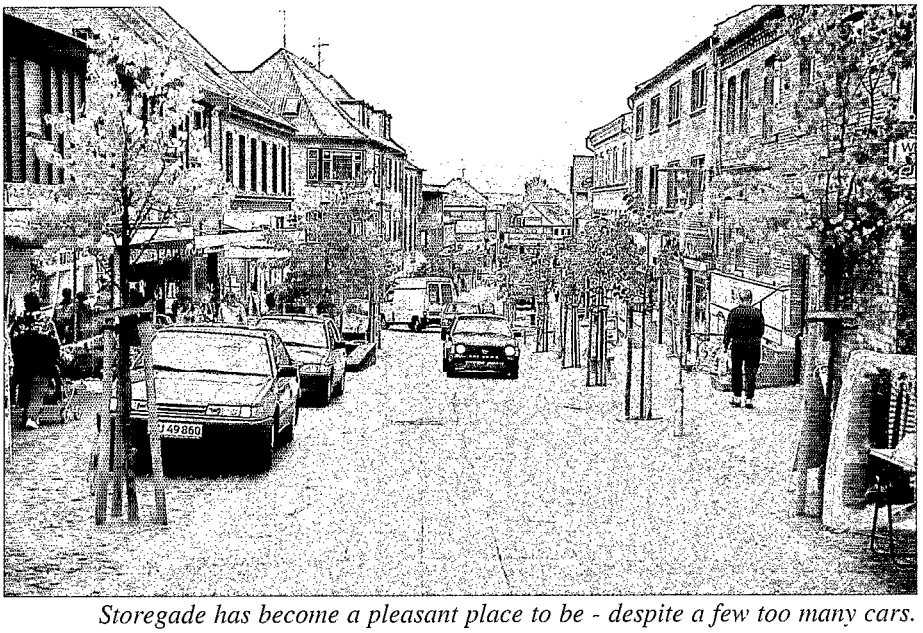
In connection with this conversion also the intersection of Storegade, Nørregade, Østergade, and Hornbechsvej in the northern end of the stretch was rebuilt. Storegade and Nørregade are connected via exit constructions, and the form of the intersection has been more clearly defined, especially by means of two zebra crossings.

Results

It is the municipality's impression that the traffic intensity has fallen, but there is still much through traffic. Therefore it is now being considered whether some of the side roads should be closed in connection with a future revision of the traffic plan.



The watercourse is a charming addition to the town scene.



Storegade has become a pleasant place to be - despite a few too many cars.

	Before	After
Car traffic	(1983) 420 vhl/h	-
Bicycle traffic	(1983) 53 vhl/h	-
Speed specified by signs	50 km/h	30 km/h
Mean speed/85% quantile both directions		(1992)
point 1	-	22/28 km/h
point 2	-	27/32 km/h

Sources: Traffic volumes: Anders Nyvig A/S. Speeds: VDL.

Shopping Street in Odense

In Odense a 12-year old traffic calming of the shopping street of Skibhusvej has been continued. Today three raised areas have been established in intersections, curb parking has been regulated, and trees and creepers have been planted.

The Street

Skibhusvej is part of Odense's traffic road network. It is one of the town's 3 north-eastern access roads, but primarily it serves the traffic from the adjacent large residential areas.

At the same time Skibhusvej is an active shopping street. Especially on a 750 m stretch from Annasholmsgade to the north almost all the ground-floor storeys are utilized for commercial functions of varying types.

These very different functions result in a massive car, bicycle, and pedestrian traffic in the street.

The Background

In 1980 the intersection Skibhusvej/ Hørdumsgade/Damhusvej was reconstructed. Damhusvej was closed, the carriageway in front of Hørdumsgade was provided with a staggering and narrowing, and a raised area was established in the intersection. The results were good: the traffic flow was reduced, speeds were lowered, and traffic safety was improved markedly *(48)*.

Road authority	Odense municipality
Project scope	
- 1st stage	400 m 45 km/h-street
- 2nd stage	500 m 45 km/h-street
Inaugural year	
- 1st stage	1992
Costs	
- 1st stage	DKK 2.2 m

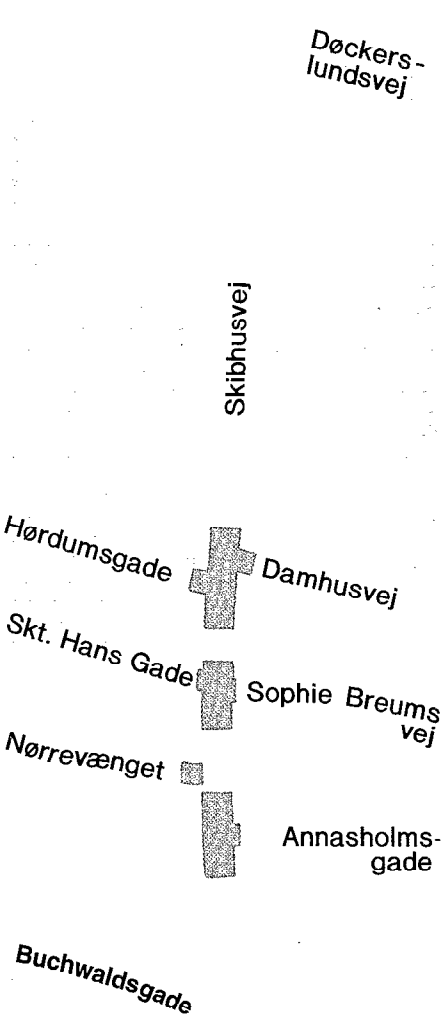
Some ten years after, however, the intersection had been worn down, and there were problems of collisions at the staggering.

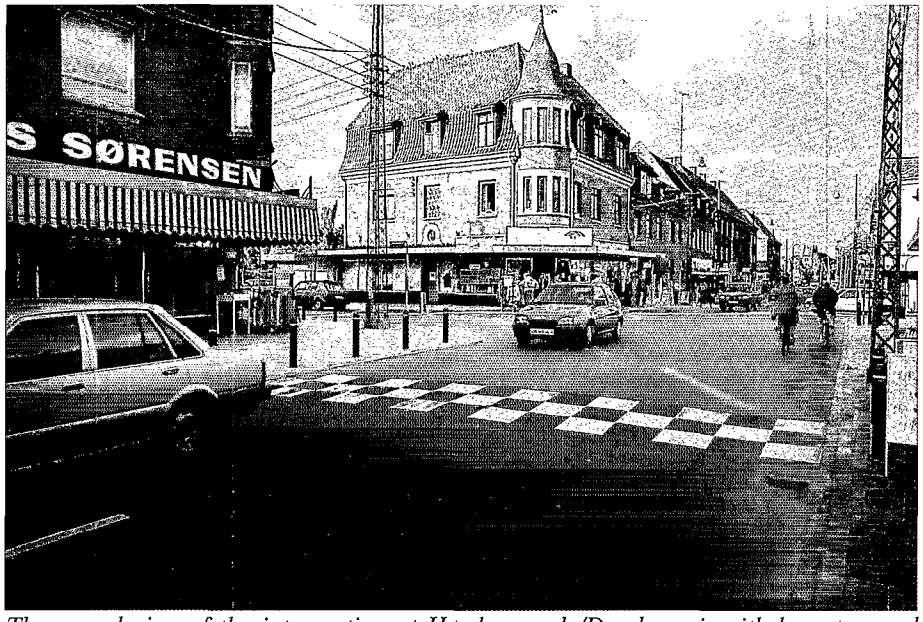
Planning

Odense municipality's main path network plan includes cycle tracks along the length of Skibhusvej. Early in 1989 an urban renewal plan, including a traffic calming plan, was passed for the Skibhus area. As it would be very difficult to find space for cycle tracks in the narrowest parts of Skibhusvej, the plan pointed to speed reduction instead. Against this background an outline design was prepared for the reconstruction of approximately 900 m of the road, from Buchwaldsgade to Døckerslundsvej.

In 1991 information meetings were held for the citizens and the local chamber of commerce, after which the town council passed the budget for the reconstruction.

In 1992 a little more than the first 400 m of the project were rebuilt. The proposed cycle tracks and central traffic islands on the remaining 500 m are scheduled for later implementation.





The new design of the intersection at Hørdumsgade/Damhusvej, with bus stop and "pedestrian pavement".

Design

The street is designed for a speed of 40-45 km/h, and signs recommend a speed of 45 km/h. The speed reduction is achieved mainly by means of raised areas with ramps in 3 intersections. The raised areas are paved with brown 10 x 30 cm concrete paving stones.

The closure of Damhusvej has been retained, but on the request of the local chamber of commerce the closure has been moved back a little from Skibhusvej in order to allow access to a car park.

Parking has been organized by the establishment of parking lanes, and bus stops have been established on both sides of the road on the raised areas of the staggered intersection with Damhusvej/Hørdumsgade and at Annasholmsgade.

The project will be completed by planting trees, primarily to mark road junctions and raised areas, and bollards and creepers in racks to further define the road alignment and the functions of individual areas.

For economic reasons the existing lighting, lamps suspended over the carriageway from wires between lattice pylons, has been retained.

Results

Traffic counts and speed measurements made in the late summer of 1992 show that the traffic intensity has fallen somewhat after the conversion and that the speed has been reduced by about 10 km/h.

It has become easier for the many pedestrians to cross the road, and the street is generally a more peaceful environment now.

	Before (1991)	After (1992)
Car traffic	7,500 vhl/24 hrs	6,300 vhl/24 hrs
Bicycle traffic	2,700 vhl/24 hrs	-
Speed specified by signs	50 km/h	45 km/h
Mean speed at point, both directions	(1991) 44 km/h	(1992) 34 km/h
Accidents, 1st stage	(1983-91)	-
- total	3.6 accidents per year	-
- involving personal injury	1.3 accidents per year	-

Sources: (48) and Odense municipality.

Shopping street in Christiansfeld

At present the Christiansfeld municipality is beautifying the town centre and improving traffic safety. As a part of this Lindegade was converted in 1992. The changes have been made with due respect for the history of the town centre, but without having nostalgia prevail.

The Town

Christiansfeld, which today has 3,100 inhabitants, was founded in 1773. Originally the town grew around two east-west streets, Nørregade and Søndergade (now Lindegade). In 1853 Kongensgade was established through the town from north to south as part of the highway connection between Kolding and Haderslev. After 1972 north-south traffic was taken by a bypass west of the town.

The Background

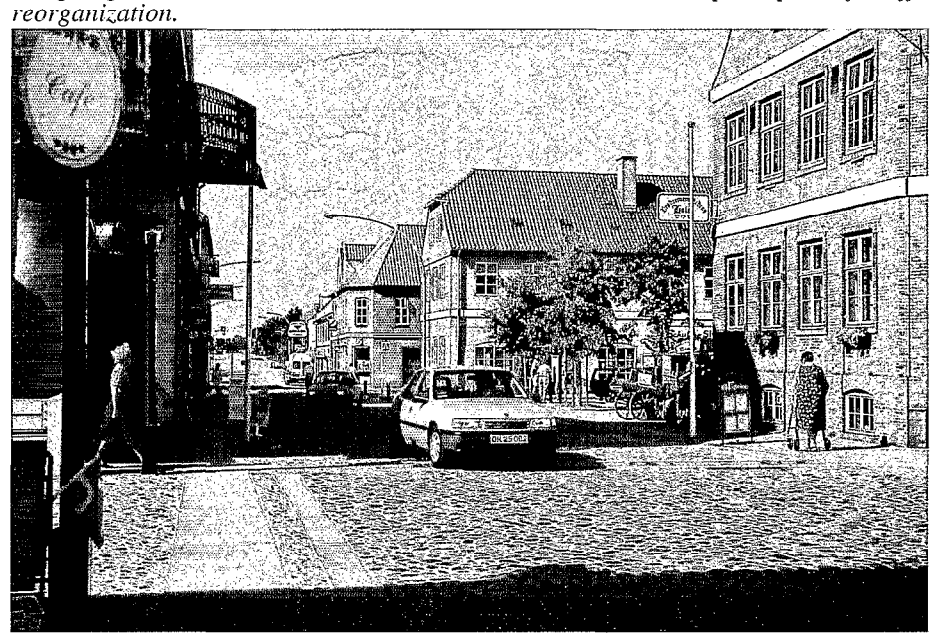
Kongensgade was designed to cope with substantial through traffic, but after the bypass was established, traffic has been modest. Therefore it has long been considered suited for redesign.

The western part of Lindegade was rebuilt in 1977/78. On both sides of the road small roadside reservations were established with trees demarcating a number of short, cobbled parking bays.

In 1991 a traffic analysis was conducted in the town to illuminate the possibilities of closing Kongensgade

Road authority	Christiansfeld municipality
Project scope	1 intersection and 100 m 30 km/h-street 4 humps
Inaugural year	1992
Costs	DKK 1.9 m

Kongensgade combines a historic environment with modern principles of traffic reorganization.



completely between Nørregade and Lindegade.

Planning

After the traffic analysis the municipality, in co-operation with a traffic-planning company, prepared traffic calming plans and concrete proposals for conversions.

Together with the results of the traffic analysis the proposals were discussed at a civic meeting in the summer of 1991, with the result that the town council opted for a project which included a conversion in stages of the eastern part of Lindegade and of Kongensgade between Nørregade and Lindegade.

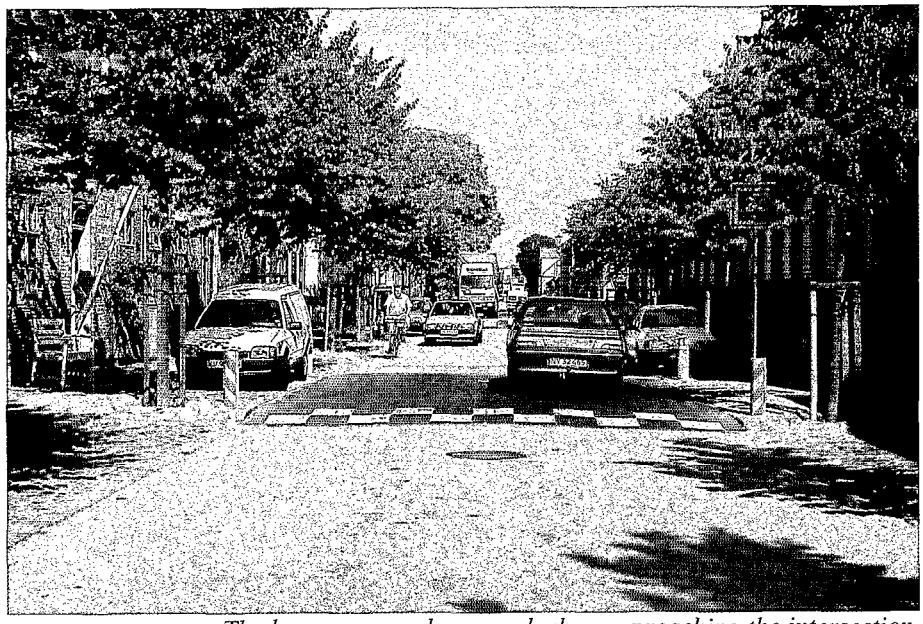
The first stage, the conversion of Lindegade, was implemented in the early summer of 1992. It has not yet been decided when the next stages are to be carried out.

Design

After the conversion the central intersection between Kongensgade and Lindegade appears as a square with no difference in level between carriageway and sidewalks. Paving types are cobbles in the accesses, rough-surfaced cobbles in the actual intersection, and bands of concrete and granite paving stones in continuation of the sidewalks of adjoining streets.

Limetrees have been planted at the corners of the intersection, and benches and lamps have been provided which are specially designed for the area.

To ensure a low speed level in the intersection circular humps have been established on the 4 access roads approximately 70 m before the intersection. The hump to the north of the intersection is an interim measure and will be moved further north when Kongensgade and the intersection with Nørregade are converted.



The humps ensure low speed when approaching the intersection.

The eastern part of Lindegade has been rebuilt on the same principles that were applied to the western part. Twenty roadside reservations with limetrees have been established, of which four mark the corners of the hump whereas the others demarcate a row of parking bays. In accordance with town tradition the trees have been planted with a spacing of 16 Hamburger "alen" (linear measure), corresponding to about 9 m.

The carriageway is still paved with asphalt, but the parking areas are cobbled and there are wide granite paving stones between the parking bays and the sidewalk. Also the sidewalk surfaces have been changed and now consist of a row of ordinary concrete slabs bordered by rough-surfaced cobbles.

There are no special facilities for cyclists.

The rebuilt area is provided with signs indicating 30 km/h as the recommended maximum speed. Normal right-of-way conditions apply in the intersection between Kongensgade and Lindegade.

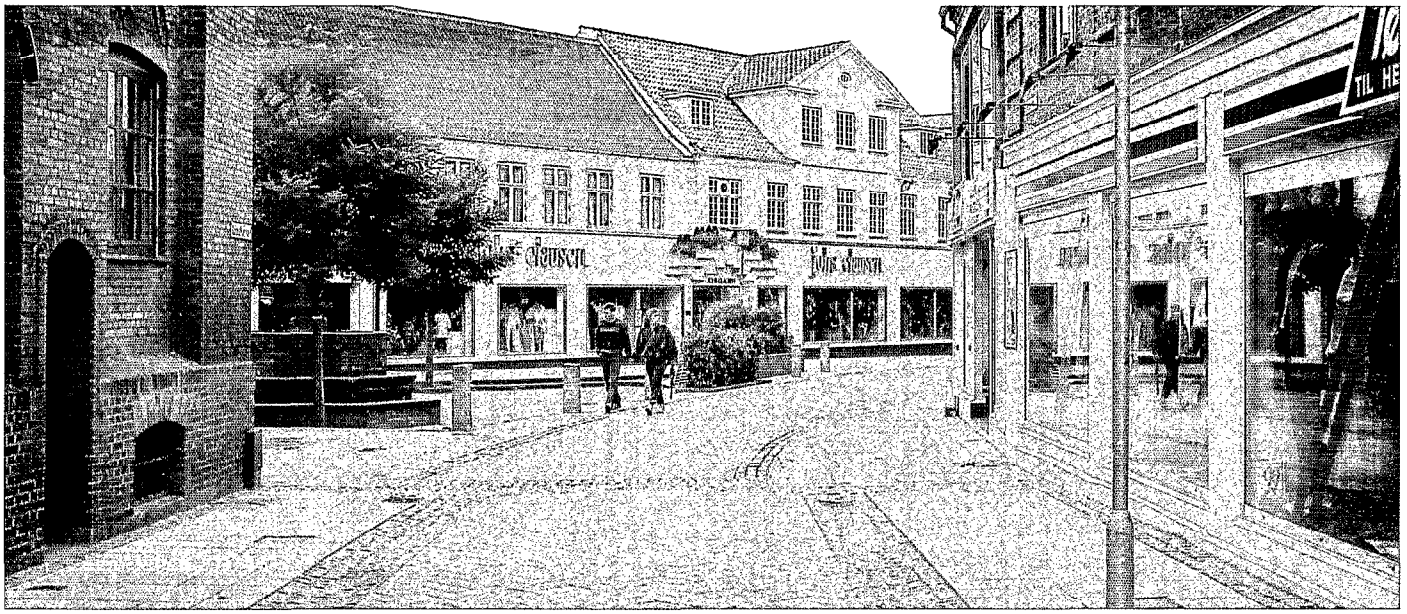
Results

Measurements made after the conversion demonstrate that the indicated speed is complied with.

	Before	After
Car traffic	(1991)	
- Kongensgade at Lindegade	3,200 vhl/24 hrs	-
- Kongensgade at Nørregade	2,500 vhl/24 hrs	-
- Lindegade, west	1,300 vhl/24 hrs	-
- Lindegade, east	3,500 vhl/24 hrs	-
Speed specified by signs	50 km/h	30 km/h
Mean speed/85% quantile at point, both directions		(1992)
- Kongensgade	-	25/29 km/h
- Lindegade	-	29/34 km/h

Sources: Car traffic: A/S Samfundsteknik. Speeds: VDL.

Town Street in Næstved



As part of an extensive reconstruction of the street network in the town centre of Næstved, Ramsherred has been converted to a pedestrian street with one-way business-related motor car traffic allowed. What used to be an ordinary town street with much too narrow sidewalks is now in its entire width designed on the premises of the light road users.

The Town

Næstved is one of six regional centres in Storstrøm County and with approximately 38,000 inhabitants it is the 4th largest town on Sealand. The urban centre is slightly more than 0.5 km^2 with many short and narrow streets. One of them is Ramsherred, which is about 200 m long, with dense roadside development interrupted only by four small squares.

The Background

Towards the end of the 1980s Næstved municipality started a conversion of streets and squares in the town centre. The intention was to create a continuous, beautiful street system adapted to the needs of the light road users, but still with the possibility for business-related motor car access.

Hjultorv and St. Peders Kirkeplads were the first to be converted. Then followed Ramsherred, and later on Vinhusgade was rebuilt and inaugurated in July 1992.

Road authority	Næstved municipality
Project scope	200 m pedestrian street with 4 small squares
Inaugural year	1991
Costs	DKK 1.3 m

Ramsherred was quite an ordinary town street with east-going, one-way traffic and a fairly unexciting visual environment. At 5-6 m the carriageway was very wide in relation to the total width of the street, and the sidewalks were correspondingly narrow, between 1 and 2 m.

Consequently, the light road users' conditions were poor and some accidents occurred on the stretch.

Planning

Experiences with the first conversions in the town centre were good. The urban space was aesthetically improved and the changes were welcomed by the citizens.

In 1991 it was therefore decided to rebuild Ramsherred, on conditions that

- the street should be granted the status of pedestrian zone
- business-related motor-car traffic and parking should still be possible
- bus services 3 and 13 should continue to run through the street

Design

The redesign was made for the stretch between Hjultorvet and St. Mortensgade/Grønnegade. It was a total conversion where the street was designed as narrow stretches alternating with open squares.

As the street is still a one-way street with east-going traffic, the narrow stretches have been designed with a

carriageway width of 2.8 m. The carriageway is paved with concrete paving stones and is bordered with 0.5 m wide, granite-set drainage channels.

The carriageway on the individual stretches of the road is staggered, as longitudinal parking bays are placed alternately on both sides of the street. Parking is limited to 30 minutes.

Along the buildings the sidewalk is paved with concrete paving stones with a granite set adjustment zone towards the house fronts.

The four open spaces are designed as little squares paved with concrete slabs, paving stones, and granite setts, and with benches, bollards, trees and flowers. On the first of the squares six 2-hour parking bays are provided.

The existing lighting has been retained in the street parts and has been supplemented with park lamps in the squares.

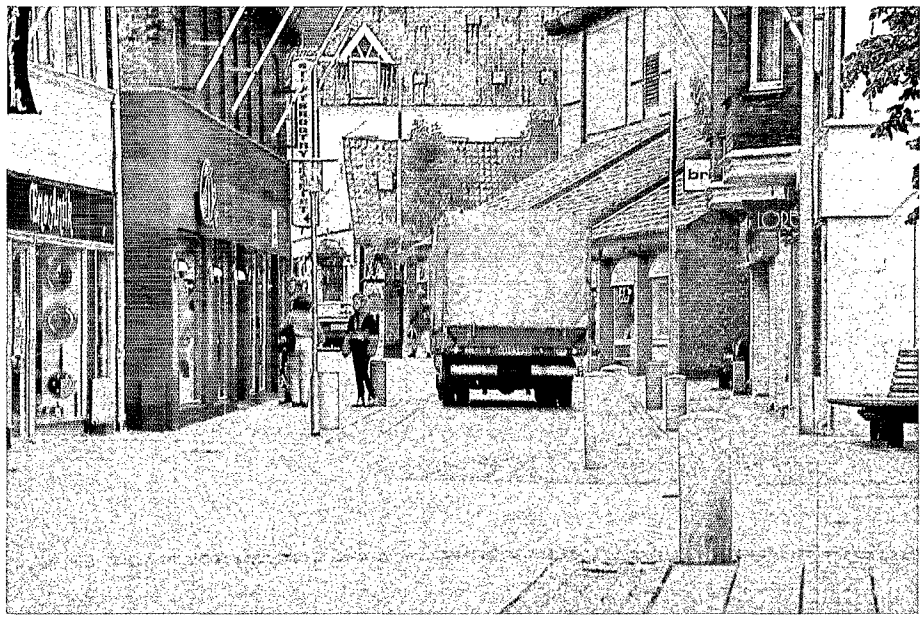
The town buses 3 and 13 now bypass the town centre and a shuttle service has been introduced on Ramsherred.

Traffic signs define it as a pedestrian zone with business-related traffic allowed.

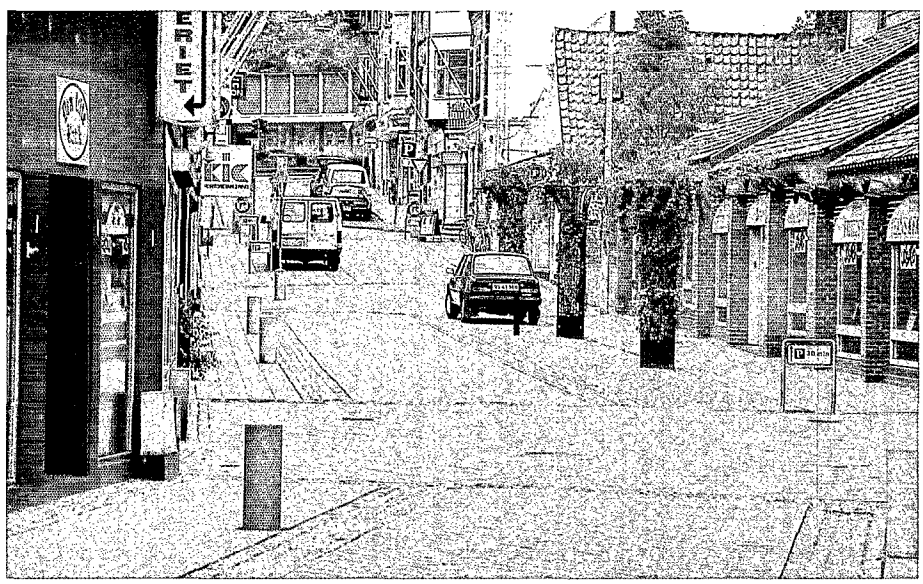
Results

Due to the traffic calming in the town centre the traffic in Ramsherred had already been halved before the conversion, from 4,100 to 2,000 vehicles a day. After the conversion the traffic intensity fell again, to 1,500 vehicles a day.

The converted section of Ramsherred was not particularly accident-prone before the redesign. By contrast, in 1991 the intersection Ramsherred/St. Mortensgade was singled out as a black spot and was converted with an exit construction towards Ramsherred and a circular hump at the southern entry from St. Mortensgade.



The lorries are fairly large, but the drivers are careful.

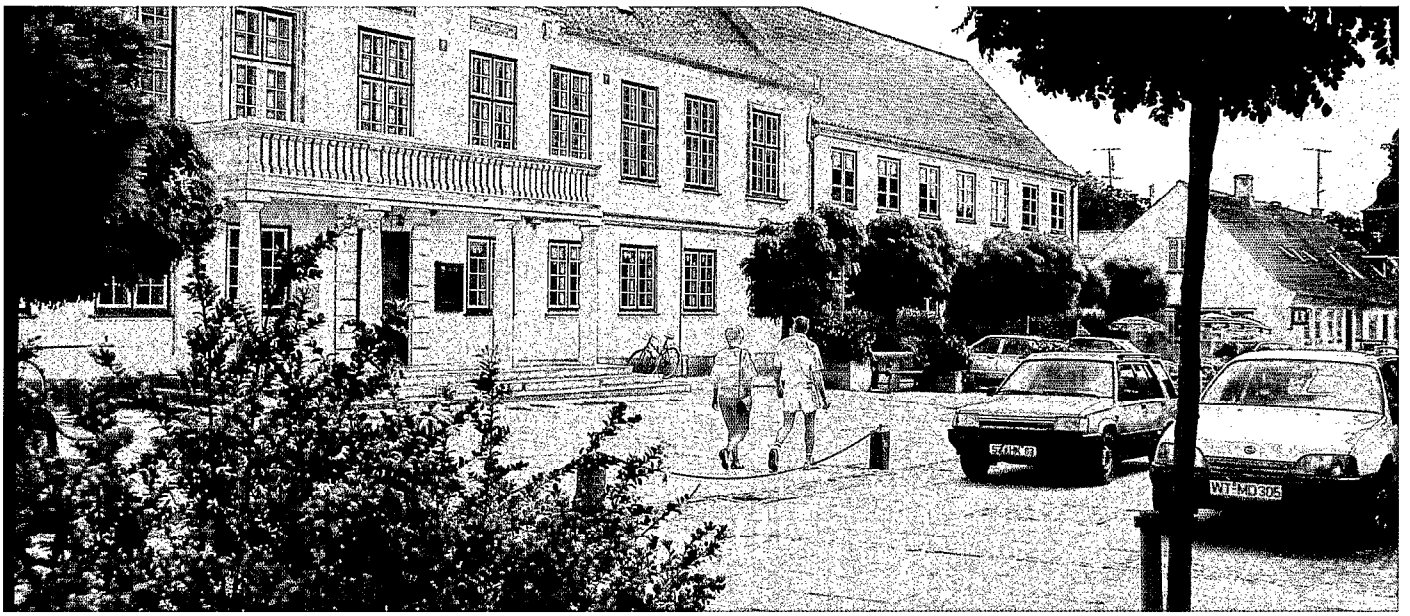


Cars are parked alternately on both sides of the road.

	Before	After
	(1987)	
Car traffic	4,100 vhl/24 hrs	
	(1990)	(1992)
	2,000 vhl/24 hrs	1,500 vhl/24 hrs
Speed specified by signs	50 km/h	Pedestrian street with cars permitted
Mean speed/85% quantile, at point, both directions	-	-
- Ramsherred at Hjultorv	-	19/24 km/h
- Ramsherred	-	26/31 km/h
Accidents	(1986-91)	-
- total	0.8 accidents per year	-
- involving personal injury	0.6 accidents per year	-

Source: Car traffic: Næstved municipality. Speeds and accidents: VDL.

Town Hall Square in Nysted



In 1980, to renew the town hall's environment and to lower car speeds in Adelgade, Nysted municipality established a square that makes the open space in front of the town hall and the street appear as one unity.

The Town

Nysted is situated on the south coast of Lolland, in Nysted Cove. The town is the municipal centre of Nysted municipality and has close to 1,500 inhabitants. It is the trading centre for part of south-eastern Lolland, it has a much visited marina, and is also known for Ålholm Castle, which lies at the western periphery of the town.

The Background

The open space in front of Nysted's town hall borders on the north-south going main street of Adelgade, where the shops and service trades are concentrated.

Through the 1970s there was felt to be a growing discrepancy between the trade going on in Adelgade and its associated mixed traffic, and relatively high car speeds.

In addition there had for many years been a wish to renew the area in front of the town hall.

Road authority	Nysted municipality
Project scope	20 x 50 m town square
Inaugural year	1980
Costs	DKK 0.3 m

Planning

In 1979 the town council decided to carry out a conversion so that the open space in front of the town hall and the adjoining stretch of Adelgade could be seen as a unity.

Consequently this became one of the first squares in the country converted in accordance with the then fairly new ideas of mixing the different kinds of traffic on the light road users' terms.

The technical administration of the municipality was in charge of the planning, and a private consultancy company carried out the design. The conversion works were made in 1980.

	Before	After
	(1979)	(1992)
Speed specified by signs	60 km/h	30 km/h
Accidents		(1981-90)
- total	-	None

Source: Nysted municipality.

Design

The square is designed as a raised area, 10 cm above Adelgade's carriageway level. The ramps to the area are 1.2 m long and the ramp gradient therefore corresponds to motor car crossing speeds of just above 30 km/h.

The ramps are paved with asphalt and the raised area is paved with 60 x 60 cm concrete carriageway slabs with granite-set drainage channels.

To avoid unwanted parking in front of the old part of the town hall the open area adjoining Adelgade is demarcated with granite bollards interconnected by chains. In spite of the uniform pavement the area therefore still appears as a street and a square respectively. To avoid collisions and to make the sidewalk alignment in Adelgade more visible, planners have considered moving the bollards 1-2 m closer to the town hall.

Those parking must make do with a total of 12 granite-set parking bays. 6 are at right angles in front of the new wing of the town hall and 6 are parallel bays along the facades in Adelgade. Otherwise, there is a public car park behind the town hall.

In conjunction with the conversion the lamp posts were replaced by "Albertslund" lamps placed in the western part of the square along Adelgade and along the town hall facade.

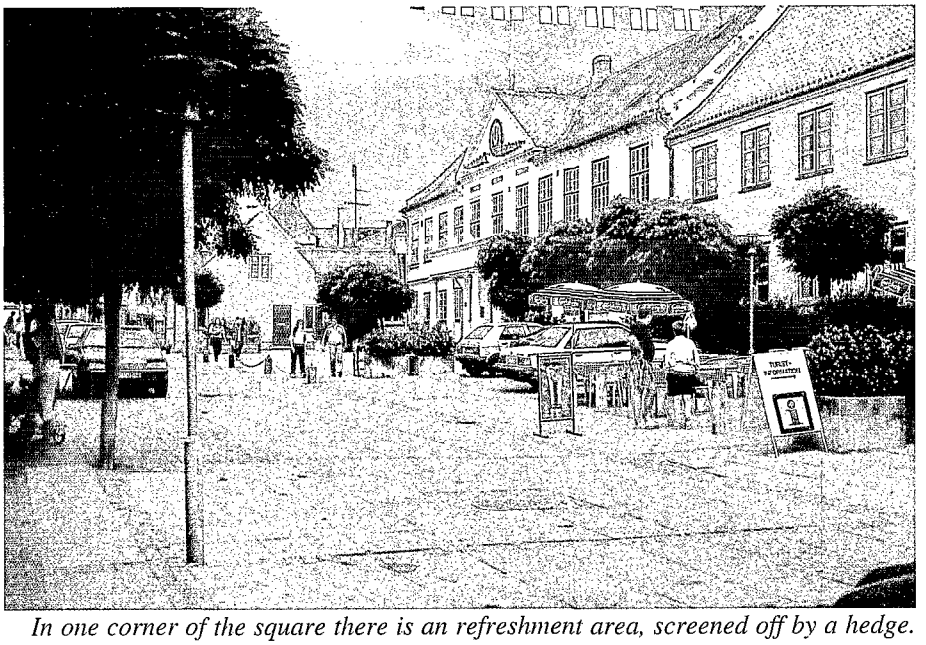
In addition, acacia trees were planted and cribs with ivy and box shrubs placed so as to emphasize the different functions of the area and to provide shelter for people on the square.

In 1992, as an experiment, a refreshment area was established in front of the new wing of the town hall.

Results

No real analyses have been made of the effects of the conversion, but the municipality's assessment is that both the speed reduction and the renewal of the square fulfil expectations.

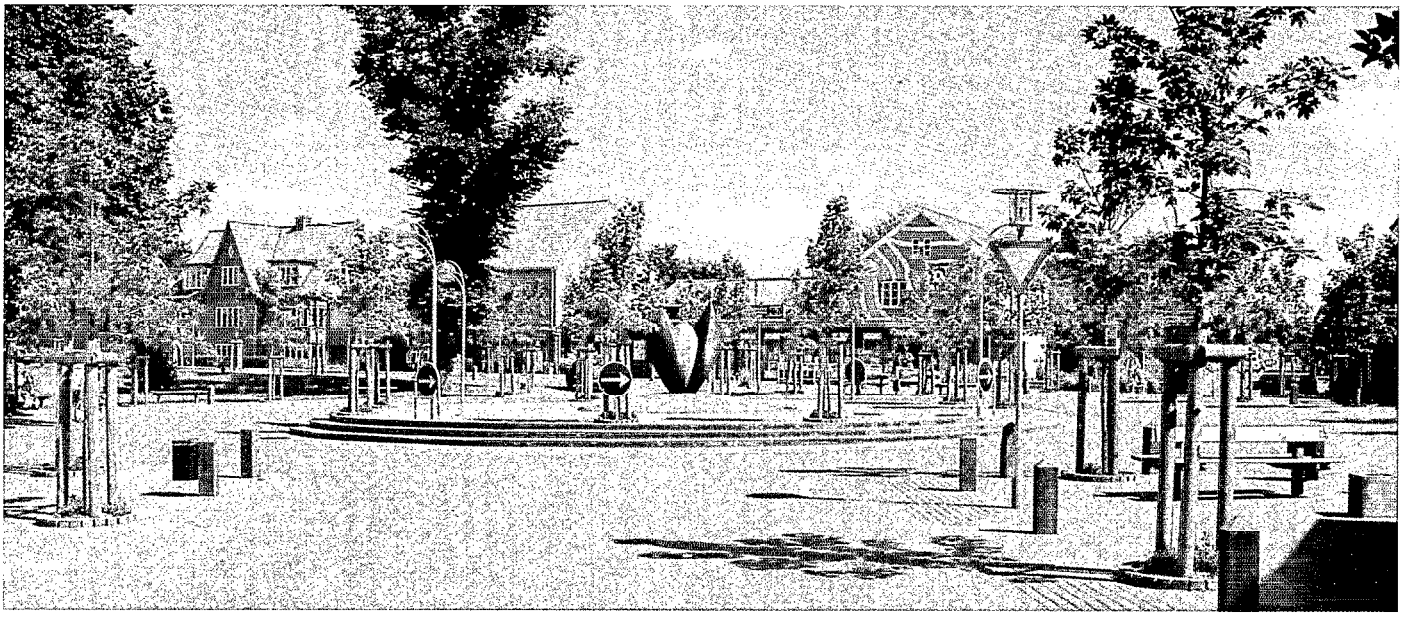
The parking bays are discreetly placed.



In one corner of the square there is an refreshment area, screened off by a hedge.

The steles separate the carriageway and the open area.

Roundabout in Vamdrup



In Vamdrup an intersection of 5 roads has been converted into a beautiful and well-functioning roundabout which not only solved a traffic problem, but also created a town space that is important for civic well-being.

The Town

Vamdrup, with 4,000 inhabitants, is the municipal centre in Vamdrup municipality south-west of Kolding, and is a typical, small provincial railway station town. With its advantageous location at the railway and close to a motorway interchange, the town and the municipality have opportunities for continued economic growth.

The Background

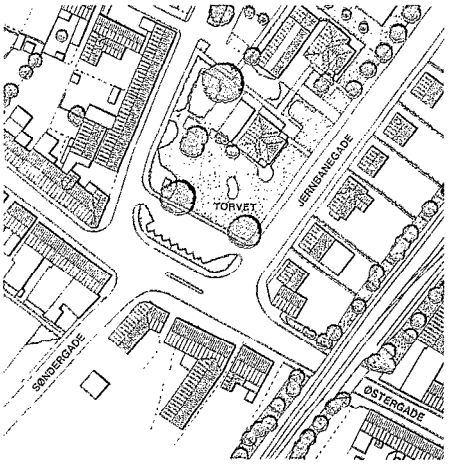
Following a decision in the second half of the 1980s the county road was made to bypass the town to the east. This meant that the traffic flow on two of the 5 streets intersecting in the town centre was halved, whereas on the other 3 it was unchanged or increased.

Traffic conditions in the 5-legged intersection were therefore still unsatisfactory. There was queuing during rush hours, and sight conditions and the right-of-way situation were chaotic.

Consequently the municipality wanted a radical change of the intersection, not only into a new traffic facility but also into an urban space that might contribute to an enhanced feeling of well-being for the inhabitants.

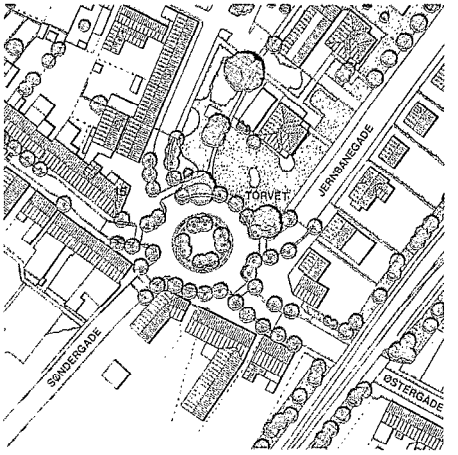
Planning

Conceptual designs were prepared that focused not only on the intersection, but also on an improvement of traffic and parking conditions in adjoining streets.

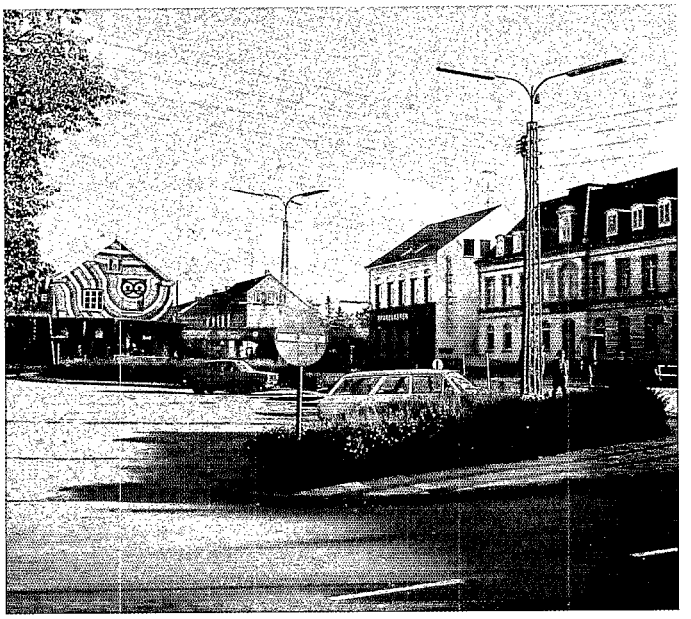


The area before the conversion.

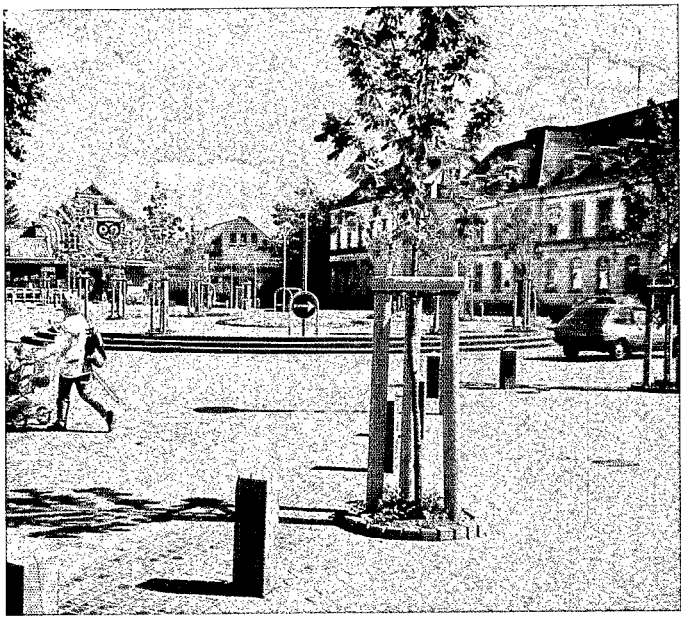
The area after the conversion.



Road authority	Vamdrup municipality
Project scope	Roundabout/square
Inaugural year	1989
Costs	DKK 2.0 m



The intersection before the conversion.



The intersection shortly after the conversion.

The ideas were presented to the town council, the most important elements were published in the local press, the different concepts were discussed with the local trade association and circulated to all private addresses in the municipality, and an exhibition was arranged.

Against the background of these experiences the town council decided, in the beginning of 1989, to change the 5-street intersection into a roundabout.

Design

The surface pavement in the entire area is coloured concrete paving stones in the modules 10 x 10, 10 x 20, and 10 x 30 cm. The same stones have been used for bordering off around plant holes and as riser stones for the three steps around the central island. The pavement has been adapted to the facades of the individual buildings, and where possible, steps have been removed to make front doors more accessible for the disabled.

For lighting of the area two types of lamps have been chosen, one type for the central island, and one for the other areas. Both are sodium lamp types for reasons of both the warm light and the low power consumption.

The furniture is benches, litter boxes, and bicycle stands placed as appropriate. Road signs are provided in accordance with the minimum requirements of the Road Traffic Act.

Maples have been planted so that they demarcate car traffic. To further emphasize the function of the square bollards have been placed in the rows of trees.

The most marked element of the scheme, however, is the fountain placed in the central island. It is beautiful in itself, and at the same time adds a strong character to the entire town space *(49)*.

Results

After the conversion traffic flows smoothly at all times of the day, despite changing traffic loads. At the same time the location has become a much used rendezvous for all age groups.

It is the municipality's clear impression that the number of accidents has been reduced after the conversion.

Already from 1990 the satisfactory result of the conversion made the municipality extend the traffic calming and environmental improvements to include the adjoining streets.

	Before	After
Car traffic	(1988)	(1992)
- Vestergade	2,000 vhl/24 hrs	1,800 vhl/24 hrs
- Østergade	4,150 vhl/24 hrs	4,100 vhl/24 hrs
- Søndergade	2,300 vhl/24 hrs	-
- Jernbanegade	3,300 vhl/24 hrs	-
Bicycle traffic		(1992)
- Vestergade	-	900 vhl/24 hrs
- Østergade	-	1,800 vhl/24 hrs
Speed specified by signs	50 km/h	30 km/h

Source: Vamdrup municipality.

Coastal Boulevard "Strandvejen" in Hellerup

The coastal boulevard Strandvejen through Hellerup is a textbook example of a heavily trafficked road where light road users have been given better conditions, among other things by the establishment of bicycle tracks and a central reservation.

The Street

Østerbrogade-Strandvejen, from Trianglen in Copenhagen to the town of Helsingør, used to be one of Copenhagen's most important radial roads.

With the establishment of the Helsingør motorway an important part of the regional traffic functions of the road disappeared. On the other hand the urban areas around and just west of the road generate a fair amount of local traffic.

At the same time Strandvejen is probably the most important excursion road in the Greater Copenhagen area - due to the sea view, the marinas, the public beaches, and the many forested areas.

On the stretch through Hellerup, Strandvejen has an additional function as one of the most important shopping streets in Gentofte municipality. This applies especially to the stretch south of Øregårdsparken, where the 4-5 storey development is almost uninterrupted, with shops at street level and mainly residential functions on the other floors.

Road authority	County of Copenhagen
Project scope	
- 1st stage	600 m highway
- 2nd stage	1,800 m highway
Inaugural year	
- 1st stage	1983
- 2nd stage	1984
Costs	
- 1st stage	DKK 5.0 m
- 2nd stage	DKK 9.1 m

Strandvejen before the conversion.

Jægersborg Allé

Pedestrians, cyclists, parked and moving cars each have their allocated area.

Maglemosevej

To the north of the park the development is rather more mixed with both detached houses and blocks of flats.

The width of the road varies from 18.6 m in the south to 26.5 m in the north. Before the traffic reorganization the road had 4 lanes over the entire length including, however, kerb parking, and cycle tracks on both sides except on the southernmost fourth.

Tranegårdsvej

There was heavy traffic. Already in 1978 20,000 cars and 1,600 bicycles/mopeds passed Øregårdsparken every 24 hrs. Based on countings of pedestrians the number of crossing pedestrians was estimated to be identical to the number of car trips on the stretch.

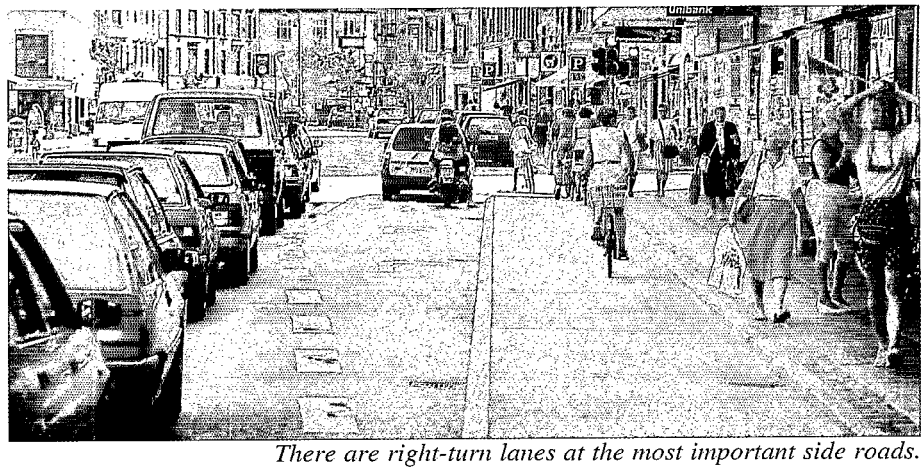
A. N. Hansens Allé

The section was governed by the general speed limit only, which at the time was 60 km/h.

Due to the kerb parking sight conditions for the many crossing pedestrians were bad. Parking cars and the lack of turning lanes caused many car drivers to change lanes often while driving straight ahead, and it was difficult for turning drivers to maneuver in an acceptable fashion because of the confined space and the poor sight conditions.

In 1980-82, the last three years before the conversion, there were, on the southernmost 600 m, a total of 52 accidents recorded by the police, 32 in intersections and 20 on straight sections. 9 accidents involved pedestrians, 12 were bicycle/moped accidents, and 31 involved only cars. Most accidents were queuing collisions, left-turn accidents, accidents involving parking cars, and accidents with crossing pedestrians.

Onsgårdsvej



There are right-turn lanes at the most important side roads.

Hellerupvej

Callisensvej

The pedestrian roadside reservations -

- and the traffic island make it easier for pedestrians to cross the road.

The Background

In the 1970s, when traffic calming in Denmark was focused on local roads, Copenhagen county understood that there were equally big problems associated with the traffic roads. Therefore studies and considerations were started regarding three of the county's most important roads, Amager Landevej, Søborg Hovedgade, and Hellerup Strandvej.

All three roads were characterized by a high rate of accidents, narrow cross-sections, through traffic, fairly dense roadside development, many shops, and restricted opportunities for establishing alternative alignments.

For all three roads these considerations and the detailed planning resulted in conversion schemes which were implemented in the beginning of the 1980s.

Planning

The studies and the subsequent planning were performed by a working group with the participation of Copenhagen County, Gentofte municipality, and Gentofte police - and in close contact with the Copenhagen City and Regional Transport.

Solutions such as material change of the use of the areas (e.g. closing of the shops), establishment of a bypass, or relief routes were found unrealistic, and the working party pointed to traffic calming as the only feasible solution.

The standard remedial measures pointed out were sidewalks and cycle tracks on both sides of the road on the entire stretch, turning lanes wherever turning was still allowed, bus laybys, parking bays, a consolidated central reservation for crossing pedestrians, and roadside reservations where there were significant numbers of crossing pedestrians.

On most stretches of the road it was impossible to combine these measures with the retention of all 4 car lanes. Priority was then given to the safety and security of the light road-users rather than to the car traffic flow, so that the final scheme operated with 2 continuous lanes plus turning lanes in the intersections. Even on the widest section on the northern stretches the option was for a 2-lane solution so as not to attract more cars than could be led through the narrowest part of the road.

The working party's outline design was presented for public discussion in the form of a 12-page publication circulated in the neighbourhoods, an exhibition of the outline design, arrangement of a public meeting with 200 participants, the invitation to submit criticism and alternative designs, and the circulation of a summarizing note to all participants in the debate.

The debate gave evidence of the general agreement on the basic principle of the outline design. Many people, however, expressed their concern about the redirection of traffic to other roads in the surroundings of Strandvejen.

Design

Due to the changing width of the road, the detailed design of the road became a series of variations on the main theme of the general design principle.

On the southernmost, narrow stretches there was not enough space for a consolidated central reservation, but only for double lines. Here, where there used to be no cycle tracks, the cross-section was most radically changed. The northern part of the road required fewer structural alterations as the existing sidewalks and cycle tracks could be incorporated almost unchanged.

To the extent possible the pedestrian roadside reservations were positioned on the basis of an analysis of pedestrians' preferred crossing points, at about 75 m intervals.

Trees were planted in the kerbed roadside reservations to indicate the existence of the points of crossing and to embellish the street scene generally.

The central reservation was designed to withstand the load of heavy vehicles. Thus a bus can squeeze past the site of a potential accident and ambulances can advance even through heavy traffic.

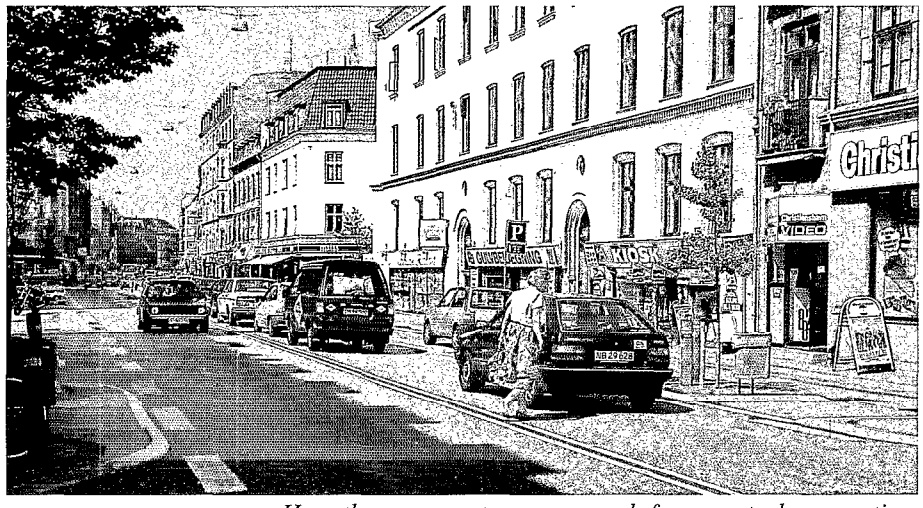
Results

Speed measurements made in 1984 after the conversion showed that the average speed had fallen in the southern direction, but had increased in the northern *(48)*.

It was also found that, by and large, the drivers accepted the new conditions so that, contrary to what had been expected, no substantial redirection of traffic took place via alternative routes.

No analyses have been made of cycle or pedestrian traffic after the conversion, but apparently their feeling of security has been improved, and the fence effect for pedestrians has probably been reduced considerably *(48)*.

Comparisons of the frequency of accidents before and after the conversion show that there has been a significant reduction. Fewer accidents are recorded in the categories of overtaking, left-turn, and parking accidents. On the other hand the number of accidents involving pedestrians and cyclists has increased, partly where bus passengers cross the cycle track when getting on or off the bus, partly where pedestrians who have to cross the road concentrate only on the car traffic *(48)*.



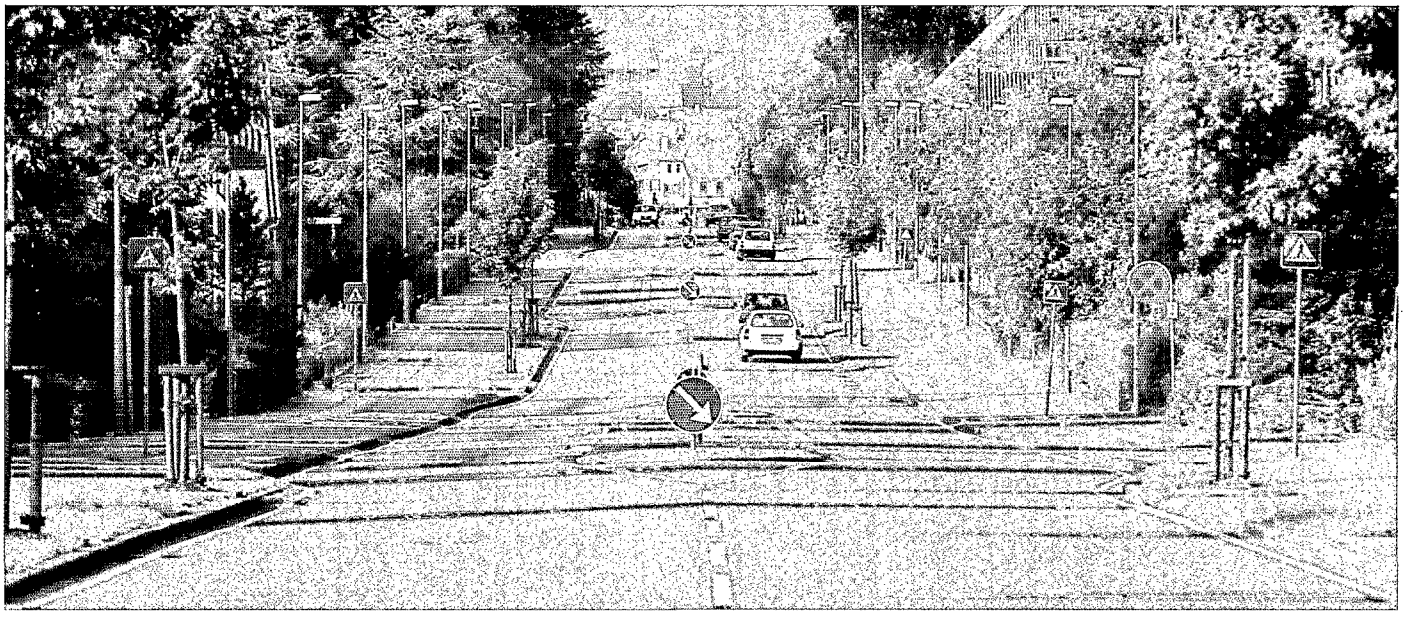
Here there was not space enough for a central reservation.

Crossing the cycle track can be dangerous.

	Before	After
	(1978)	(1987)
Car traffic	20,200 vhl/24 hrs	18,200 vhl/24 hrs
Bicycle traffic	(1978) 1,600 vhl/24 hrs	-
Crossing pedestrian traffic	(1978) 7,400/7 hours	-
Speed specified by signs	60 km/h	50 km/h
Mean speed/85% quantile both directions		(1992)
- point at 1st stage	-	44/52 km/h
- point at 2nd stage	-	53/62 km/h
Accidents 1st stage	(1980-82)	(1985-91)
- total	17.3 accidents per year	9.1 accidents per year
- involving personal injury	6.0 accidents per year	4.6 accidents per year
Accidents 2nd stage	(1981-82)	(1985-91)
- total	21.5 accidents per year	14.0 accidents per year
- involving personal injury	12.0 accidents per year	6.4 accidents per year

Sources: County of Copenhagen (48). Accidents and speeds: VDL.

Highway through Aabenraa



The three km long, heavily trafficked highway through Aabenraa has been converted according to the principles of environmentally adapted through roads, with due respect paid, however, to the substantial traffic flow. This has reduced car speeds, has made a coherent bicycle route network, has resulted in a falling number of accidents, and has increased the feeling of security for the light road users.

The Town

Aabenraa is one of the four regional centres in the county of Southern Jutland. It has 15,600 inhabitants and thus ranks among the 20 largest towns in Jutland.

The town is a centre for the regional public transport system, and the port has regional importance.

The converted highway runs through the town from north to south under the names of Haderslevvej, H. P. Hanssens Gade, Skibbroen and Kystvej.

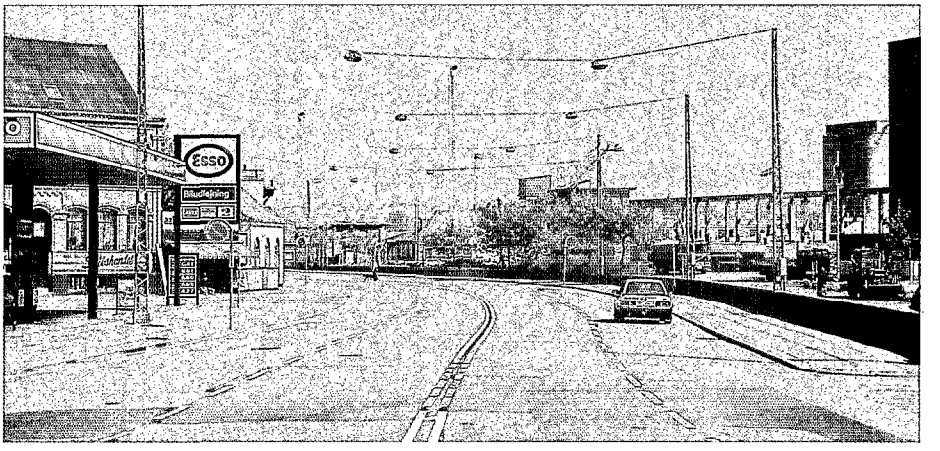
The Background

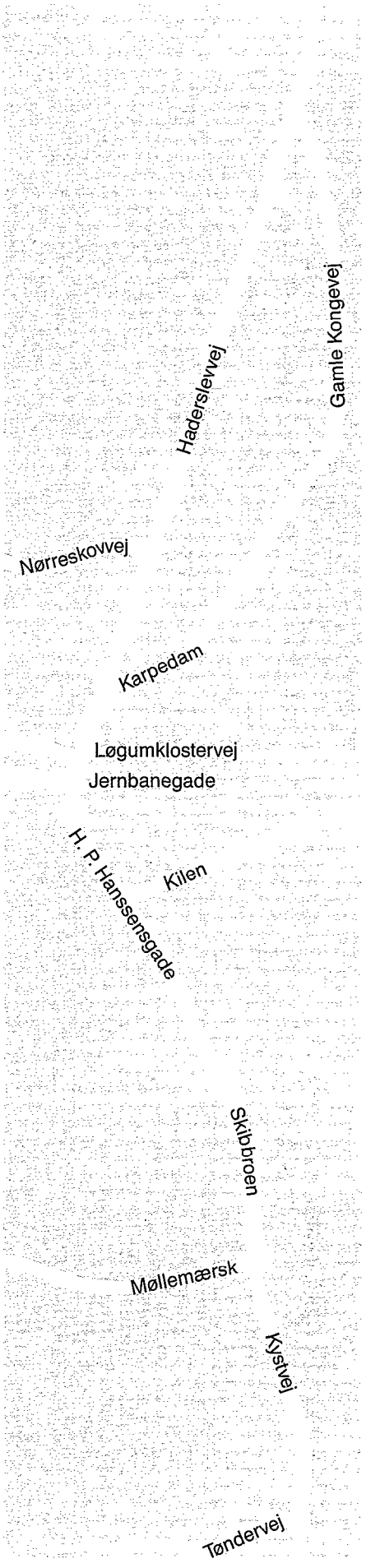
When the motorway of Southern Jutland was opened in 1982, the highway through Aabenraa was declassified to an ordinary highway. It now constitutes part of the overall road network as part of the route Kruså-Aabenraa-Haderslev-Kolding, parallel with the motorway. The traffic between Aabenraa and the neighbour towns of Kruså and Haderslev still use the highway, which is the fastest route. Especially the road's role as the connection between the harbour and the surroundings generates some heavy traffic.

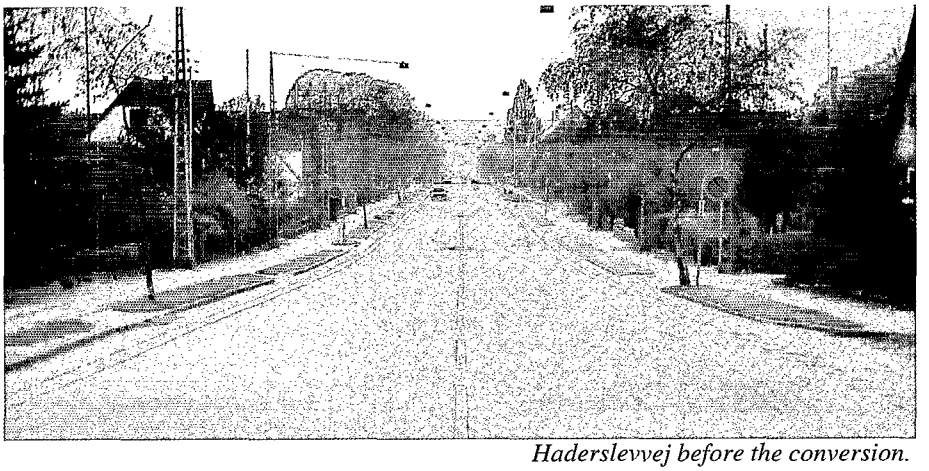
Road authority	County of Southern Jutland
Project scope	3.1 km highway
Inaugural year	1991
Costs	DKK 25 m

Haderslevvej is the approach road to the town from the northern surrounding area and is also an important school route. H.P. Hanssens Gade-Skibbroen is part of Aabenraa's inner ring road.

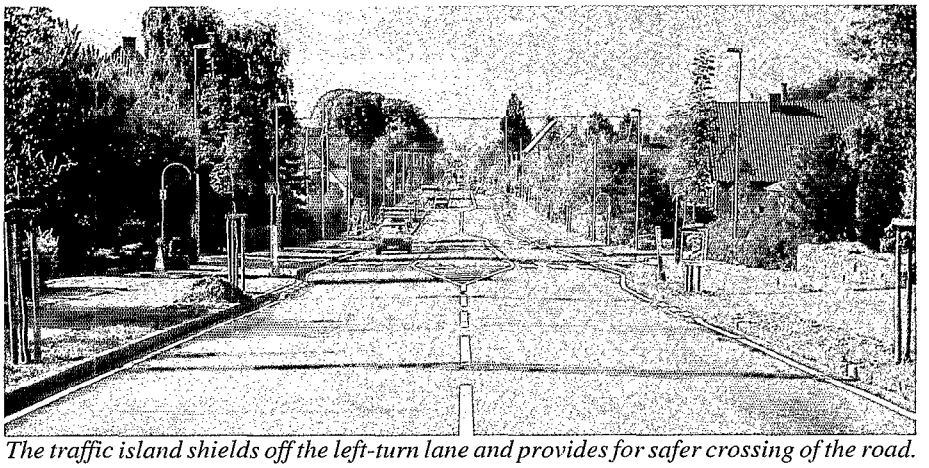
Skibbroen before the conversion.







Haderslevvej before the conversion.



The traffic island shields off the left-turn lane and provides for safer crossing of the road.

Planning

As a consequence of the agreements made in connection with the declassification a working party was established in 1984 with representatives from the county of Southern Jutland, Aabenraa municipality, and Gråsten police district. Their brief was to prepare a design for cycle tracks along the road.

The working party, which was in constant contact with the Danish State Railways and Danish Cyclists' Association had a traffic plan worked out for the road and its surroundings. Side roads were classified and the most important path intersections were identified.

Against this background a detail design was prepared, first for Haderslevvej and subsequently for the remaining stretch.

The project was implemented in stages in the period 1988-91.

Design

At the town limit on the northern part of Haderslevvej a gate has been established by means of trees and lighting, and here the carriageway is narrowed down from 10.5 to 8.0 m.

Cycle tracks have been established along the whole stretch, but as divided paths, i.e. cycle track and sidewalk at the same level, but with different surfaces. The total width of 3.75 m is made up of 2.0 m cycle track and 1.75 m sidewalk.

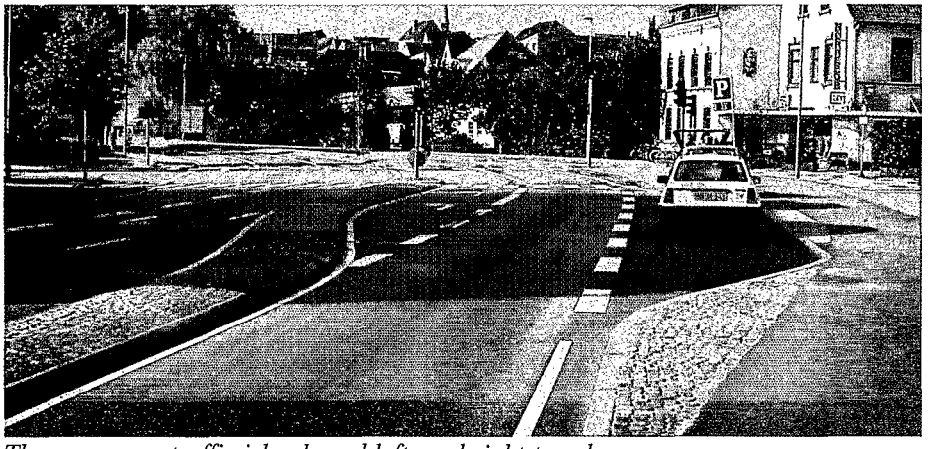
Before the conversion Haderslevvej consisted of 2 carriageway lanes each 4.25 m wide, 1 m edge lane on each side, and sidewalks varying between 2.5 and 3.5 m's width. On the northernmost part of the stretch there were also 1 m wide strips with trees between the edge lanes and the sidewalks.

Now a number of central traffic islands have been established which both re-

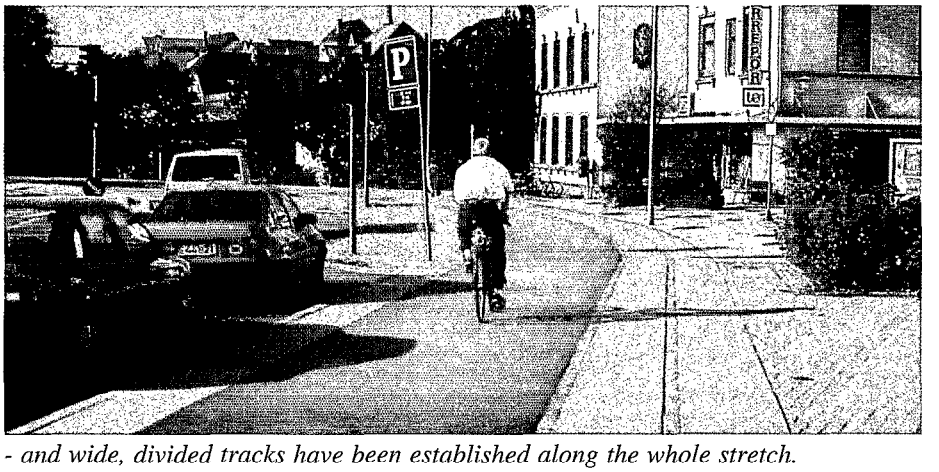
The gate at the northern approach. The carriageway has been narrowed, trees have been planted, and the lighting has been changed.

duce speeds and ensure that pedestrians can cross the road in two stages. The islands are designed so that pedestrians will automatically face the traffic they have to cross. The principles are illustrated on the photos page 55 and page 120.

The islands are placed so that they help to form canalizations with left-turn lanes at side roads. Between the intersections the road still has 2 lanes, now 4 m wide, and 1.2 m wide strips planted with trees between the carriageway lane and the divided track.



There are now traffic islands and left- and right-turn lanes -



- and wide, divided tracks have been established along the whole stretch.

Before the conversion, the other half of the stretch, H. P. Hanssens Gade-Skibbroen-Kystvej, was a 4-lane road with 3.1 m wide lanes, 2.5-3.3 m wide sidewalks, and on the southernmost section also with 1 m wide edge lanes on both sides.

Now this stretch has one through lane of 3.5 m in each direction, and a central, 3.0 m wide area that is used for traffic islands and left-turn lanes alternately. There are also 2.5 m wide right-turn lanes in the intersections, and on the southern part of the stretch there are roadside reservations with trees.

The bus stops have been improved along the whole stretch. Several station stops have been established with a passenger platform between the bus layby and the cycle track, and on Haderslevvej, where there are two points with restricted space, a narrow bus layby has been made by discontinuing the dividing strip, and a narrow passenger platform has been placed on part of the cycle track.

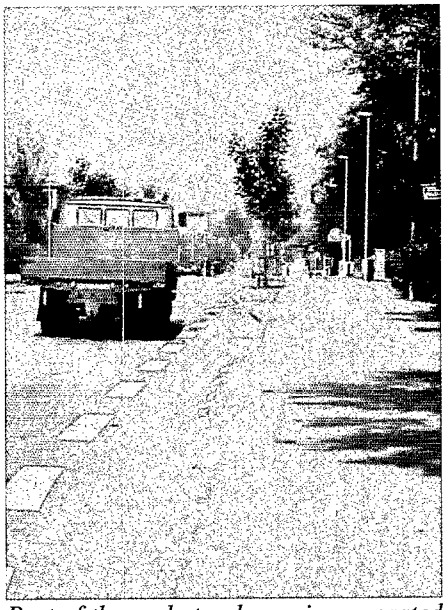
There were, and still are, a number of fairly short parking lanes on the stretch.

During the conversion one of the 7 traffic-light controlled intersections on the stretch was abolished, as Jernbanegade, which joined the street not far from Løgumklostervej, was instead turned to join Løgumklostervej. Incidentally, this is phase one of a long-term plan which is to redirect through traffic from H.P. Hanssens Gade to Gasværksvej.

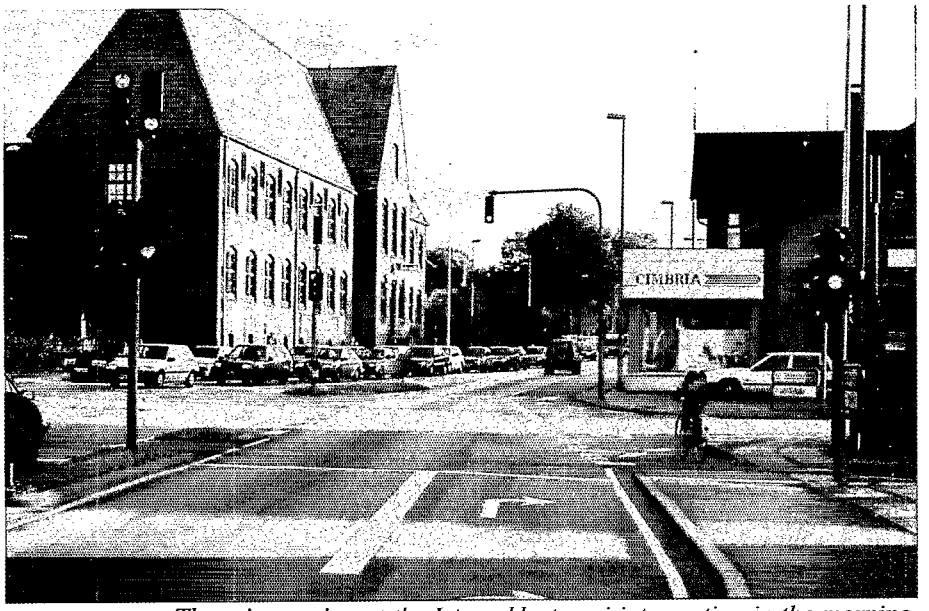
In addition, several driveways and small access roads have been closed, made one-way, or otherwise had restrictions imposed on them.

Results

The county of Southern Jutland has described the effects of the conversion through traffic counts, speed measurements, and accident analyses, and through more subjective evaluations of



Part of the cycle track was incorporated as a passenger platform.



There is queuing at the Løgumklostervej intersection in the morning.

the qualities and shortcomings of the scheme.

From 1985 to 1992 the traffic increased by 25-30%, against an expected 12%. However, this did not cause greater capacity problems than expected. Nevertheless, there are certain problems for the traffic from the north in the intersection at Løgumklostervej, and the restricted opportunities for overtaking have caused some queuing, mostly due to slow, agricultural vehicles and the like.

Average speeds on Haderslevvej and on H.P. Hanssens Gade have fallen by 4 and 2 km/h respectively, and the fraction driving faster than 60 km/h has diminished.

From 1979 to 1984 there were 53 accidents on straight sections and 68 in intersections on the stretch. 3 accidents were fatal, 51 involved personal injury, and 67 material damage. 38 accidents involved light road users. Several intersections and straight stretches had been singled out as black spots.

The conversion has resulted in a reduction of the number of accidents, but not in the number of accidents involving light road users.

On Haderslevvej, which in the before-conversion had 4.6 accidents per year, there were in a 3-year period after the conversion 5.1 accidents per year, due to a substantial increase in the first year. Since then the accident rate has fallen to a level slightly below the pre-conversion rate.

If the annual number of accidents on the entire stretch from before the conversion is compared with the first year after the whole conversion has been completed, there is a reduction from 18 to 13 accidents per year.

	Before	After
	(1985)	(1991)
Car traffic	10-12,000 vhl/24 hrs	13-16,000 vhl/24 hrs
Cycle traffic at town centre	300-1,200 vhl/24 hrs	400-1,600 vhl/24 hrs
Speed specified by signs	50 km/h	50 km/h
Mean speed/share > 60 km/h at point		
- Haderslevvej	58 km/h/41%	54 km/h/21%
- H.P.Hanssens Gade	54 km/h/24%	52 km/h/16%
Accidents on Haderslevvej	(1979-84)	(1988-07.92)
- total	4.6 accidents per year	5.1 accidents per year
- involving personal injury	2.2 accidents per year	2.7 accidents per year
Accidents in the intersection Haderslevvej/Løgumkl.v.	(1979-84)	(1988-07.92)
- total	4.0 accidents per year	0.9 accidents per year
- involving personal injury	2.2 accidents per year	0.4 accidents per year
Accidents on H.P. H.´s Gade	(1984-88)	(1991-07.1992)*
- total	9.4 accidents per year	6.7 accidents per year
- involving personal injury	2.2 accidents per year	3.3 accidents per year

Source: County of Southern Jutland.

**Accidents on H.P. Hanssens Gade uncertain due to short after-period.*

Highway through Vinderup

Vinderup was one of the first towns where the principle of environmentally adapted through traffic was implemented. The results were very positive: traffic safety was improved, car speeds were lowered, and light road users were given better conditions than previously.

The Town

Vinderup stands on the Struer-Langå railway line and on both sides of the highway between Holstebro and Skive. The town has about 3,000 inhabitants and is the municipal centre of Vinderup municipality.

Road authority	Danish Road Directorate
Project scope	1,200 m arterial highway
Inaugural year	1985
Costs	DKK 9.0 m

The stretch of the highway through Vinderup is 1,200 m long with roadside development on both sides. The central 500 m constitute the main street of the town, with many shops and therefore many crossing pedestrians.

The highway before the conversion.

The Background

In 1981 the Danish Road Directorate published "Hovedlandeveje gennem byer-et idékatalog"(Highways Through Towns - a Catalogue of Ideas). Here the concept of "environmentally adapted through traffic" was introduced and defined as a conversion implemented to give priority to the environment and the needs of the light road users. Road-crossing opportunities were to be improved, the light road users' share of the road area should be increased, and

great importance should be attached to the prevention of accidents. Consequently, car traffic would have to be led through at a lower standard of ease, mainly at a reduced speed.

The methods specified in the catalogue of ideas were new and unproven. It was therefore decided that full-scale tests should be conducted in three towns in a co-operation between the Road Directorate and the counties and municipalities involved. The pilot towns chosen were Vinderup, Skærbæk, and Ugerløse.

First of all it should be shown, in the three towns, how conversions according to the new principles would look and secondly, the effect of the conversions were to be carefully studied. With the latter in mind the Road Directorate started the so-called EMIL-project (Effect of MILieu adapted through traffic)

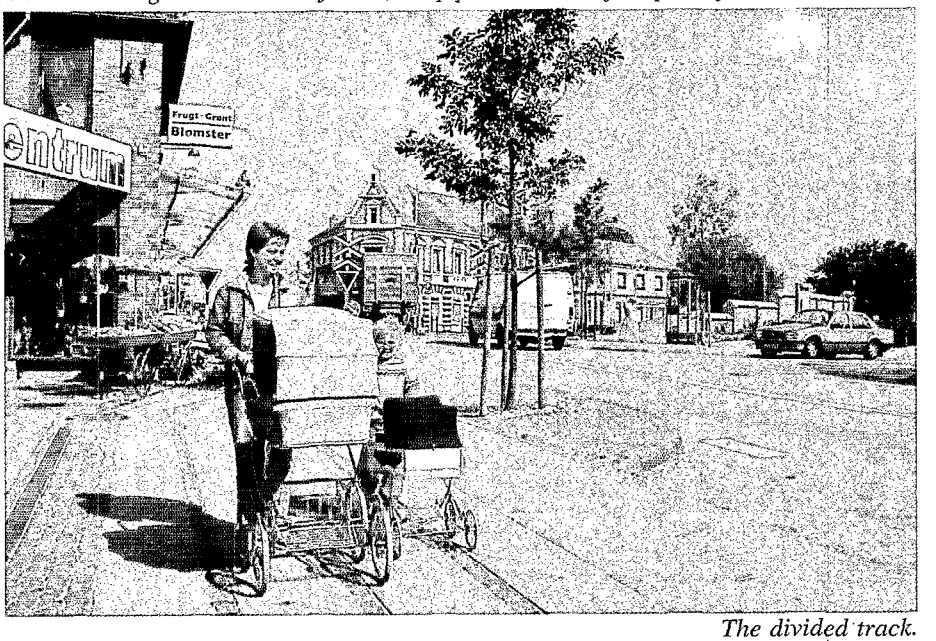
Planning

As a basis for the conversion a total traffic reorganization plan was prepared for the whole town. Among other things the plan designated the highway as a traffic road with speed reduction, and it determined main path connections, points of road crossing, and road junctions. The recommended speed for the highway through the town was 40 km/h.

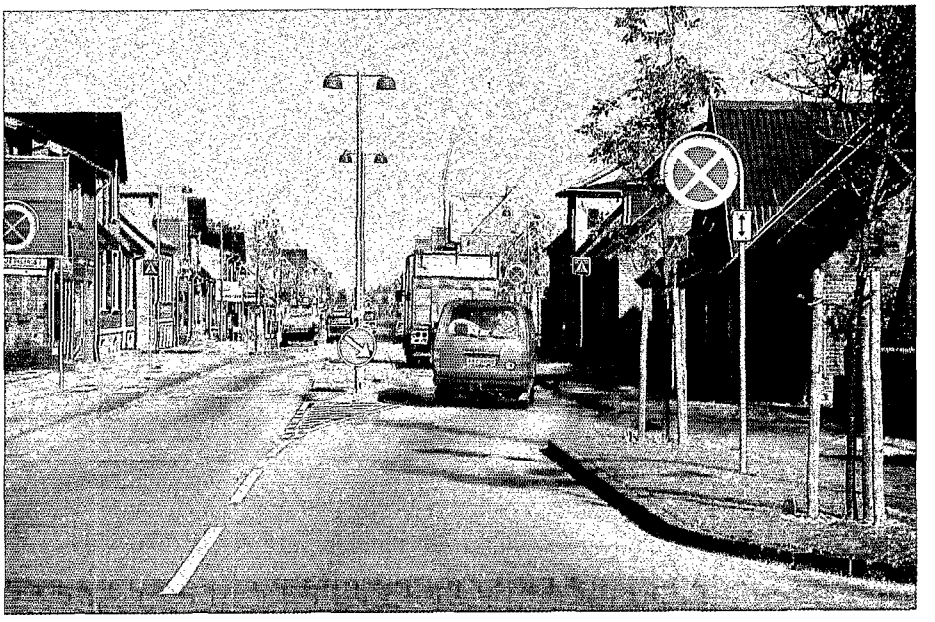
Against this background a sketch of the road section was worked out including the position of speed reducers, and it was decided that divided tracks (cycle track and sidewalk with no difference in level) should be established on both sides of the road, plus a few parking bays, with otherwise no stopping.

The planning and design was managed by a project group staffed by the Road

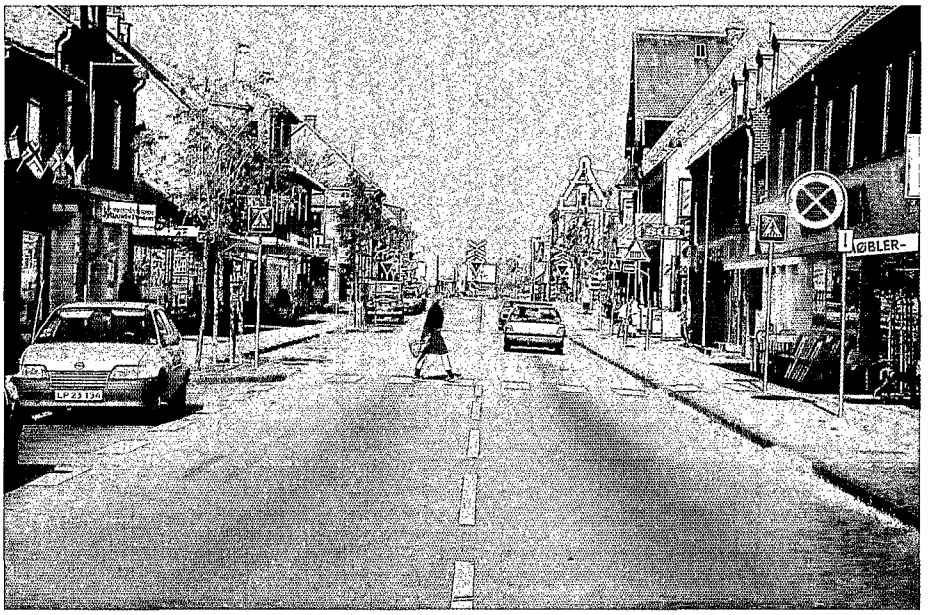
The southern gate with rows of trees, lamp posts, and the first part of the divided track.



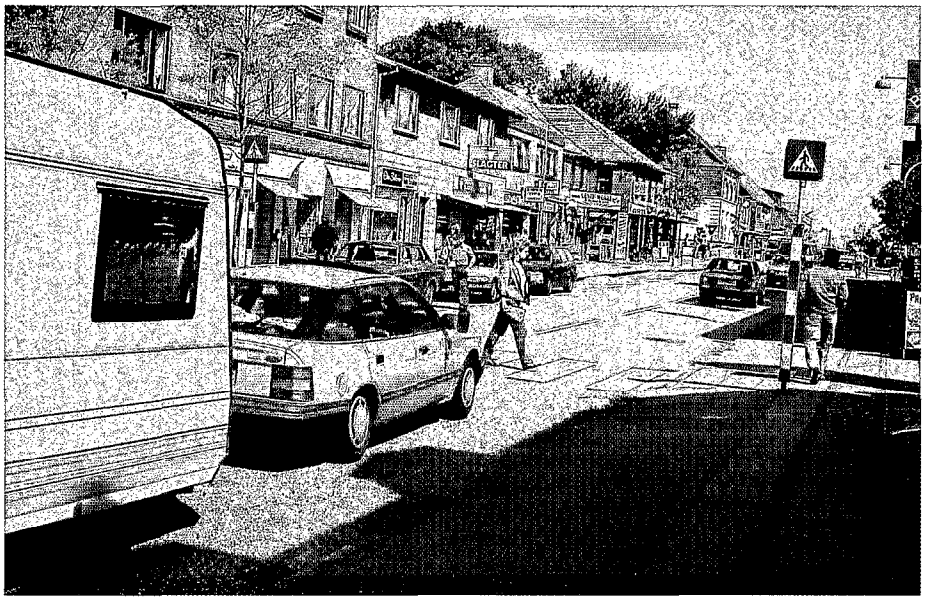
The divided track.



Before the double path crossing at Kirkegade a staggering has been established by means of a roadside reservation and a traffic island. The staggering reduces car speeds and the traffic island facilitates crossing for the pedestrians.



In the central part of the town the drivers' attention has been sharpened by means of changed road surfaces delimited by a zebra crossing at both ends.



There are just as many cars as before, but they drive more slowly.

Directorate, Ringkjøbing county, and Vinderup municipality. Meetings were also held with the police and the local chamber of commerce and, on several occasions, with the general public.

Design

The design for the conversion included a number of speed reducers

- pre-warnings with rumble strips
- gates with narrowing, plantings, and lighting
- path crossings with traffic islands
- path crossings with changed surfaces
- staggerings made with roadside and central reservations

The pre-warning with 3 rumble fields has later been abolished due to noise problems.

The gates are marked by rows of trees and lamp posts. From this point the carriageway is narrowed down and the divided track through the town starts.

In the path crossings the traffic island partly results in lower car speeds due to the staggering of the lanes, and partly facilitates crossing for pedestrians.

At the bus stop in the central part of the town the drivers' attention is further sharpened by means of a changed road surface between two zebra crossings.

The staggering of the carriageway has been achieved by means of both traffic islands and roadside reservations. The latter, which have vegetation, shield off parking bays that are placed alternately on both sides of the road.

Irrespective of the number of individual speed reducing measures the scheme for the section through the town emphasized the overall co-ordination and the aggregate effect of the individual elements, both as regards traffic and architecture.

The EMIL-project

The EMIL-project, i.e. the study of the effects, is probably the most thorough analysis ever made of such a scheme *(11)*. The study included before- and after-studies of

- car traffic (traffic volume, speeds, delays, car drivers' adjustment of driving patterns, and road user behaviour on both main and side roads)
- light road users (trafic volume, fence effect, delays, security, and town use)
- environmental impact (noise, vibrations, air pollution)
- accidents
- operation and maintenance
- shopping (purchasing patterns, number of customers, turnover)
- inhabitants' attitudes
- car drivers' attitudes

Results

The conversion did not give rise to a redirection of the traffic. Nevertheless, after the conversion many fewer inhabitants felt that the traffic on the main street was very heavy or unacceptable.

Car speeds were reduced by up to 9 km/h, least in the central part of town and most in the periphery. Particularly

the speed of heavy vehicles was reduced and very high speeds disappeared almost completely *(11)*.

The number of cyclists and pedestrians on the main street has increased considerably after the conversion. The inhabitants feel that it has become easier to cross the road, which has caused an increase in this kind of traffic by 63%.

In spite of the increased number of crossing pedestrians and cyclists, the conversion has resulted in fewer traffic accidents and fewer casualties. The total number of accidents has almost been halved and the number of accidents with personal injury has been reduced to 1/3 during a 5-year period after the conversion compared with the corresponding period before the accident *(28)*.

The feeling of security has been significantly improved. Hence, now only slightly less than 30% of the light road users on the main street express a feeling of insecurity as compared with almost 70% previously *(14)*.

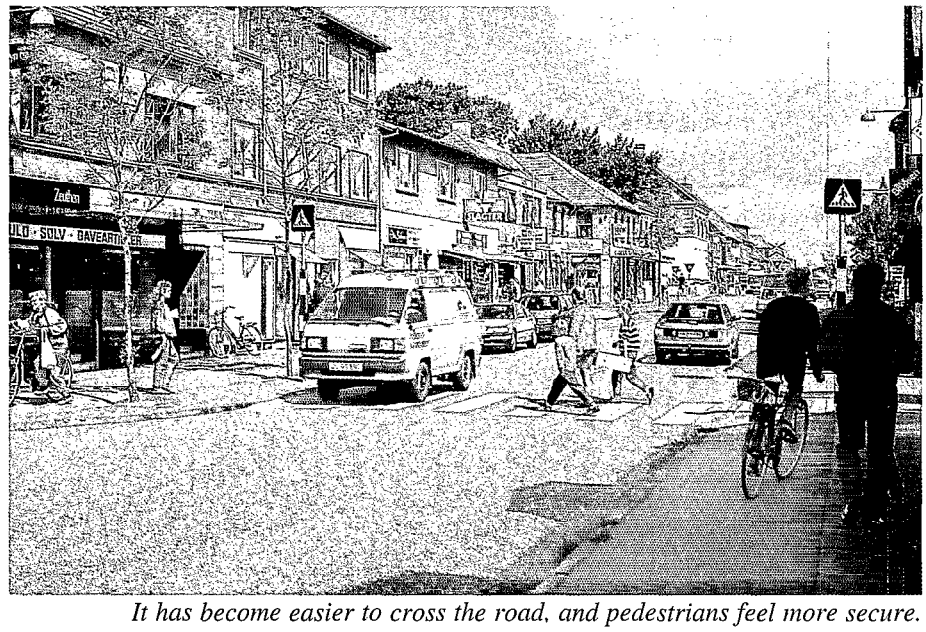
The conversion did not cause any changes in the buying patterns in Vinderup. And generally the shopkeepers are pleased with the conversion, particularly against the background of the alternative, i.e. a bypass.

As regards pollution and fuel efficiency the only significant change was an increase of the noise and the vibrations at the rumble fields before the entries into the town. Nevertheless, the number of inhabitants who feel bothered by noise or air pollution has been reduced considerably.

All in all the EMIL investigations demonstrate that the conversion has been a success. Car speeds have been reduced, the number of accidents has been lowered, and the inhabitants' feeling of security has been improved.

Percent of respondents	+	0	÷
The town has become better/worse to move about in	72	11	17
We feel more/less secure in the main street	60	23	17
The appearance of the town has been improved/impaired	94	4	2
It has become easier/more difficult for pedestrians to cross the main street	75	16	9
It has become easier/more difficult for cyclists to cross the road	54	35	11
Cars drive more slowly/faster	72	27	1
Traffic noise has decreased/increased	19	67	14
Air pollution has decreased/increased	2	87	11

The inhabitants' evaluations (14).

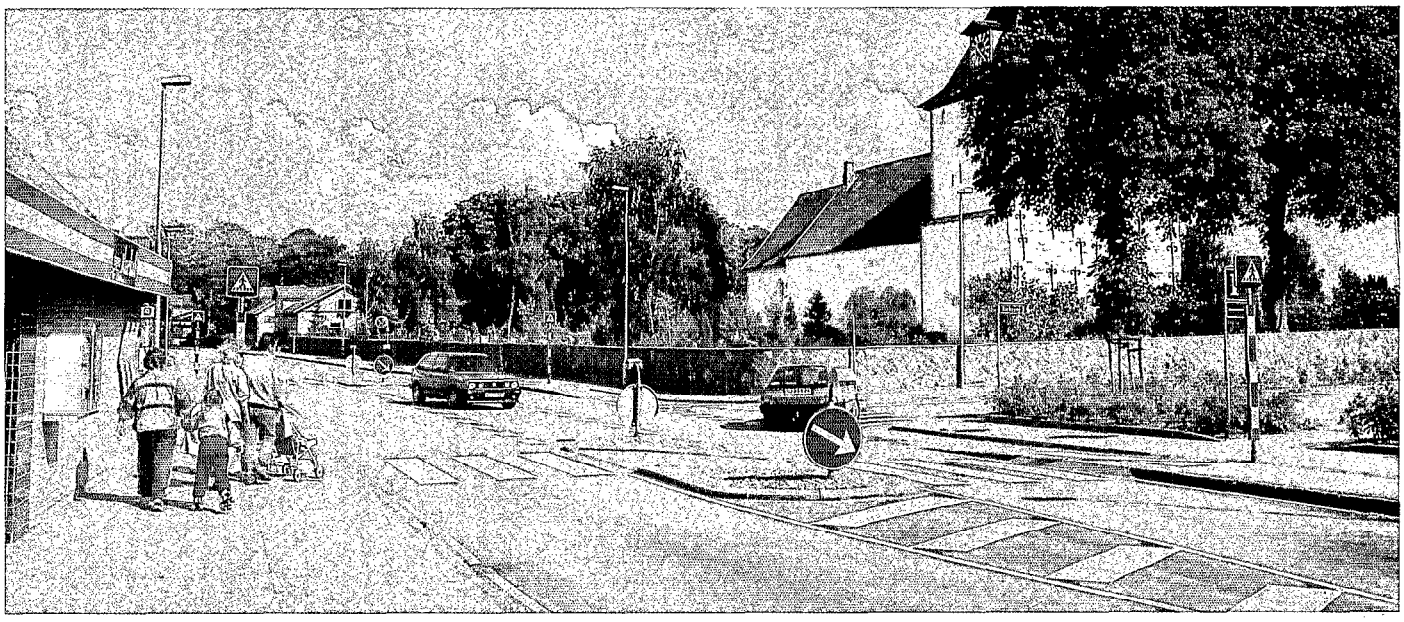


It has become easier to cross the road, and pedestrians feel more secure.

	Before	After
	(1983)	(1985)
Car traffic	3.800 vhl/24 hrs	3.900 vhl/24 hrs
Speed specified by signs	60 km/h	40 km/h
Mean speed/share >60 km/h, both directions	(1983)	(1985)
- point 1 south	51 km/h/20%	42 km/h/3%
- point 2 midtown*	42 km/h/10%	43 km/h/4%
- point 3 midtown	42 km/h/7%	38 km/h/1%
- point 4 north	64 km/h/65%	55 km/h/30%
Accidents	(1979-83)	(09.85-09.90)
- total	4.8 accidents per year	2.6 accidents per year
- involving personal injury	2.6 accidents per year	0.8 accidents per year

Source: VDL. **point 2 not quite the same before and after.*

Highway through Tinglev



The Danish Road Directorate has rebuilt the almost 2 km long highway stretch through Tinglev according to the principles of environmentally adapted through traffic. Both a great need for cycle tracks and a general wish to improve the traffic environment have been fulfilled.

The Town

Tinglev is the municipal centre of Tinglev municipality in Southern Jutland and has 2,700 inhabitants.

The highway between Tønder and the motorway junction at Torp runs through Tinglev. It is the shopping street of the town, and the town school is placed there as well.

The Background

In 1982 the municipality had sought, unsuccessfully, to become one of the three towns where the pilot projects on environmentally adapted through traffic were to be conducted.

In 1985 the highway section was included on the list of national path priorities on the basis of the proposed establishment of one-way cycle tracks on both sides of the road. On this list the cycle tracks were shortlisted for implementation.

Road authority	Danish Road Directorate
Project scope	1,700 m highway and town square
Inaugural year	1990
Costs	
- highway	DKK 14.5 m
- town square	DKK 0.4 m

Planning

In 1987 a working party was established with representatives from Southern Jutland county, Tinglev municipality, and Tønder police district. Their brief was to prepare an outline design for the cycle tracks etc. through Tinglev.

Pedestrians automatically face the traffic they have to cross.

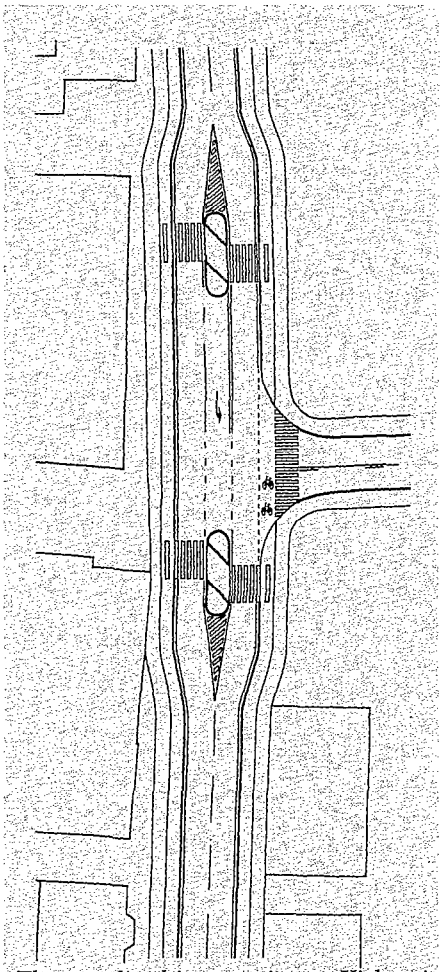
As a basis for the project a traffic plan was worked out for the section, including the designation of side roads as traffic roads or local roads.

Design

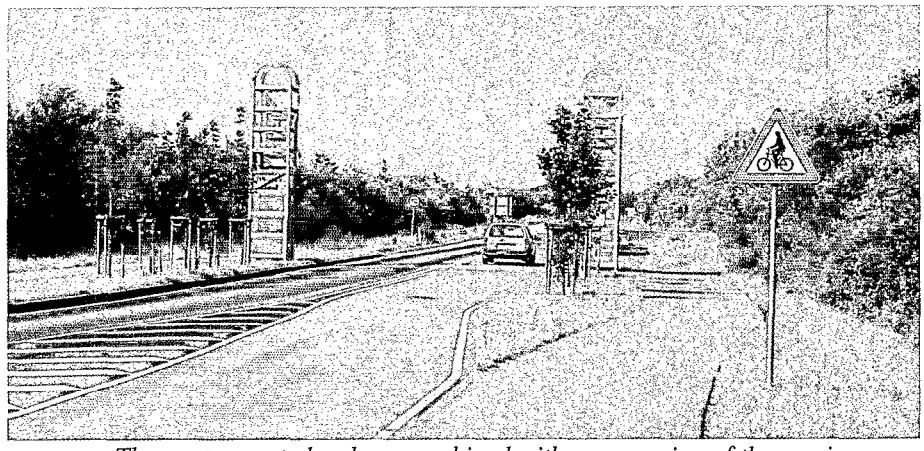
Prior to the conversion the road had 2 lanes each 4.5 m wide, with 2.1 - 2.35 m wide sidewalks on both sides. On a short section between Gyden and Nørreengvej, however, the total cross-section is only 12 m wide.

Today there is on both sides of the road a 3 m wide divided track with equal areas allocated to cycle track and sidewalk. The carriageway has been narrowed to two lanes each 3.25 m wide, 3.5 m where passing traffic islands.

In addition canalization has been provided in the intersections together with traffic islands which also secure the path crossings. The islands are designed so that pedestrians will automatically be facing the traffic they have to cross.



The canalized intersection at Kirkevej.



The western gate has been combined with a narrowing of the carriageway.

On certain stretches 2.0 m wide parking laybys have been incorporated, separated from the cycle track by a narrow reservation. The bus laybys at the bus stops are 2.75 m wide, with narrow waiting platforms towards the cycle track.

At traffic road junctions to the highway the divided tracks are marked off as cyclist crossing and zebra crossing across the road junction. Local road junctions to the highway are in the form of exit constructions, and a few have been closed.

Trees have been planted in some of the traffic islands and roadside reservations, and where roads have been closed. In addition new lamp posts and lamps have been provided.

At each end of the stretch a gate has been erected in the form of two steel tower structures, in the western end supplemented by plantings and combined with a narrowing of the carriageway.

Results

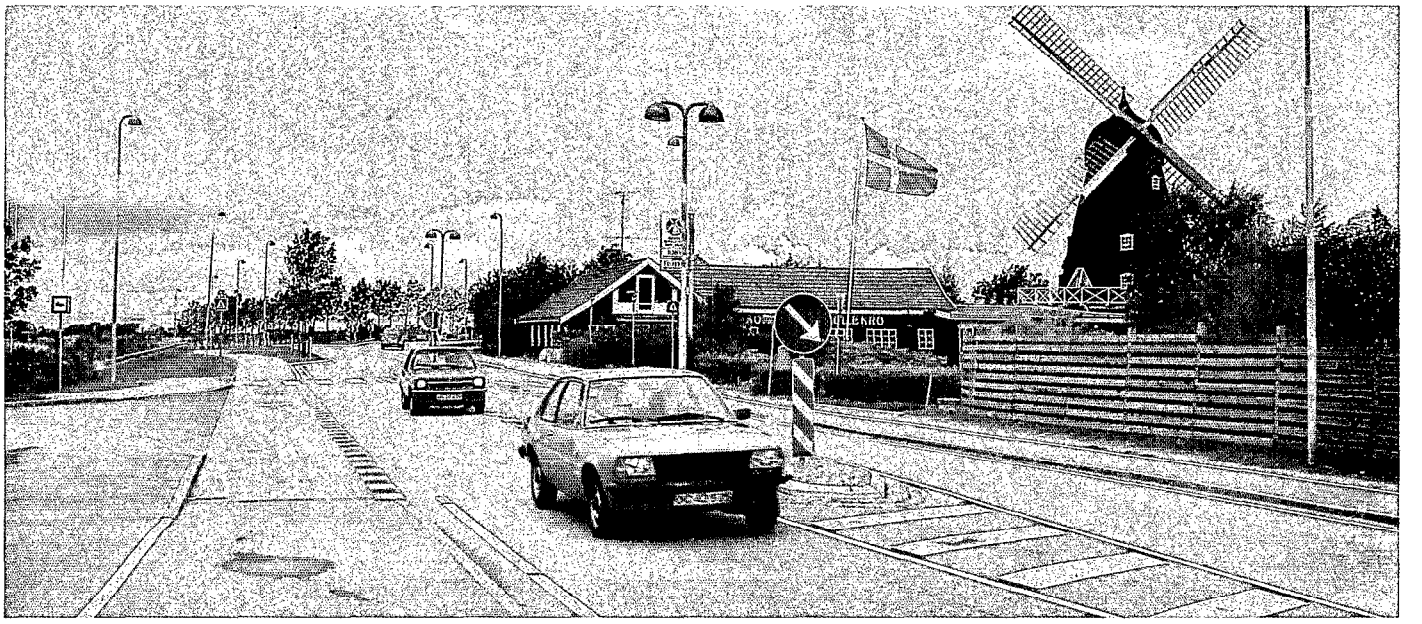
Counts made before and after the conversion show that it has caused no changes of the traffic intensity.

Before the conversion no less than 92% of the cars drove faster than the allowed 60 km/h, and 14% drove faster than 80 km/h. After the conversion signs recommend a speed of 50 km/h. The average speed has fallen by 16 km/h, but nevertheless 80% exceed the 50 km/h allowed today. 27% drive faster than 60 km/h, and 3% faster than 80 km/h.

	Before (1986)	After (1991)
Car traffic	3,700 vhl/24 hrs	3,900 vhl/24 hrs
Speed specified by signs	60 km/h	50 km/h
Mean speed/share > permitted at point, both directions	(1988) 73 kmt/t/92%	(1990) 58 km/h/80%
Accidents	(1985-89)	(1990-91)
- total	4.2 accidents per year	3.5 accidents per year
- involving personal injury	2.0 accidents per year	2.0 accidents per year

Source: County of Southern Jutland.

Highway through Vipperød



The highway through Vipperød has been rebuilt according to the principles of environmentally adapted through traffic. This has resulted in lower car speeds, and the road is far prettier than before.

The Town

Vipperød is a town in Holbæk municipality, in the county of Western Sealand, and stands on the highway between Roskilde and Holbæk.

The town has 2,200 inhabitants and a disproportionately modest trading activity. Thus, there are only few shops on the highway section through the town.

The Background

In 1969 the motorway around Vipperød was opened and the traffic through the town was reduced considerably. However, the highway still functioned as the main approach road to Holbæk from the south-eastern surrounding area, and by the mid-1980s the traffic intensity was about 4,500 cars per day.

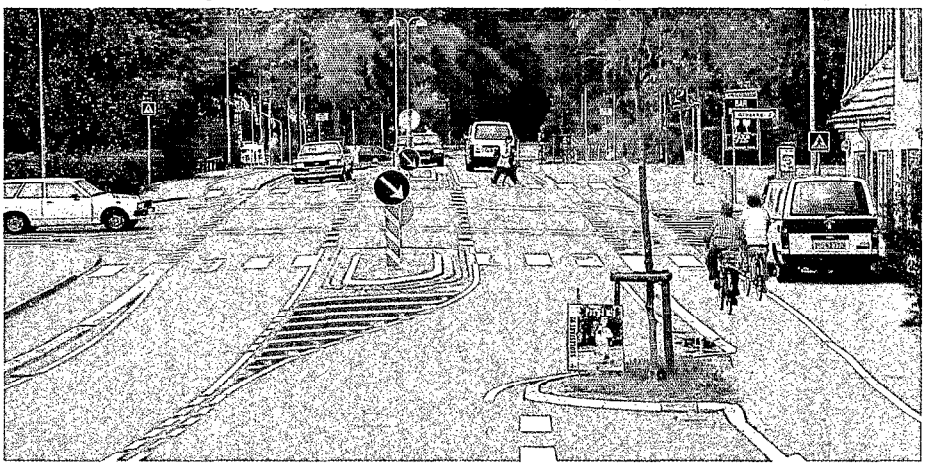
The wide carriageway and the straight alignment tempted people into speeding. Thus, in 1984 the average speed was measured to be 65 km/h. People felt insecure when crossing the street, and a large intersection in the middle of the town which many school children had to cross caused some anxiety both with children and parents. Additionally, quite a few accidents happened both in the intersection and on the remaining stretch.

Road authority	County of Western Sealand
Project scope	900 m highway
Inaugural year	1986
Costs	DKK 4.2 m

Planning

Consequently, in 1985, the county of West Sealand decided that the road had to be converted in compliance with the then quite new principles of environmentally adapted through traffic.

The central island protects the pedestrians, and the staggering lowers car speeds.



The following objectives were defined as a design basis: Car speeds were to be lowered to maximum 50 km/h. Safe crossing points should be provided for pedestrians. Cycle tracks and sidewalks had to be established on both sides of the road. And finally the traffic safety had to be improved in the central intersection.

Design

Outside the town limit rumble strips have been established which, together with a pre-warning sign, tell drivers that they are approaching a town.

At the town limit a town gate has been created with trees and kerbed roadside reservations which narrow down the carriageway visually, although the width is unchanged here.

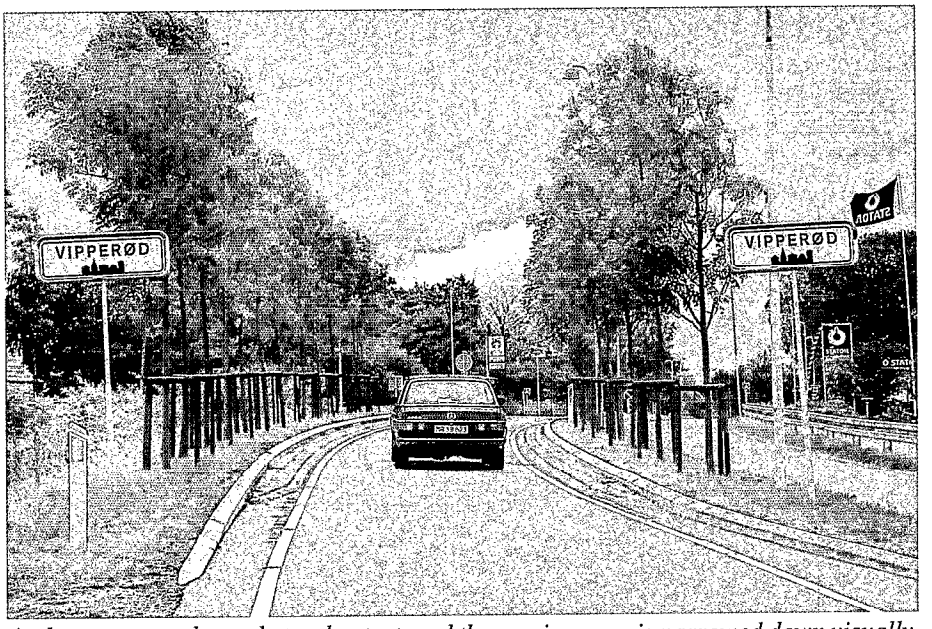
Further on into the town the original road width is reduced from 9.0 m to 6.5 m. The remaining 2.5 m are utilized for parking or roadside reservations with trees.

Cycle tracks have been established along the entire stretch, either as shared or divided tracks.

Central traffic islands are provided in all intersections. First of all they ensure safer crossing for pedestrians and secondly, in conjunction with the roadside reservations, they cause a staggering of the carriageway and thus a lowering of car speeds. To accommodate wide-track agricultural vehicles the perimeter of the islands are paved with three rows of cobbles founded on a base that resists heavy loads.

Results

To judge from the information available, the town inhabitants are satisfied with the conversion. However, they would have liked the large intersection to have been traffic-light controlled, but the traffic intensity was too low for this.



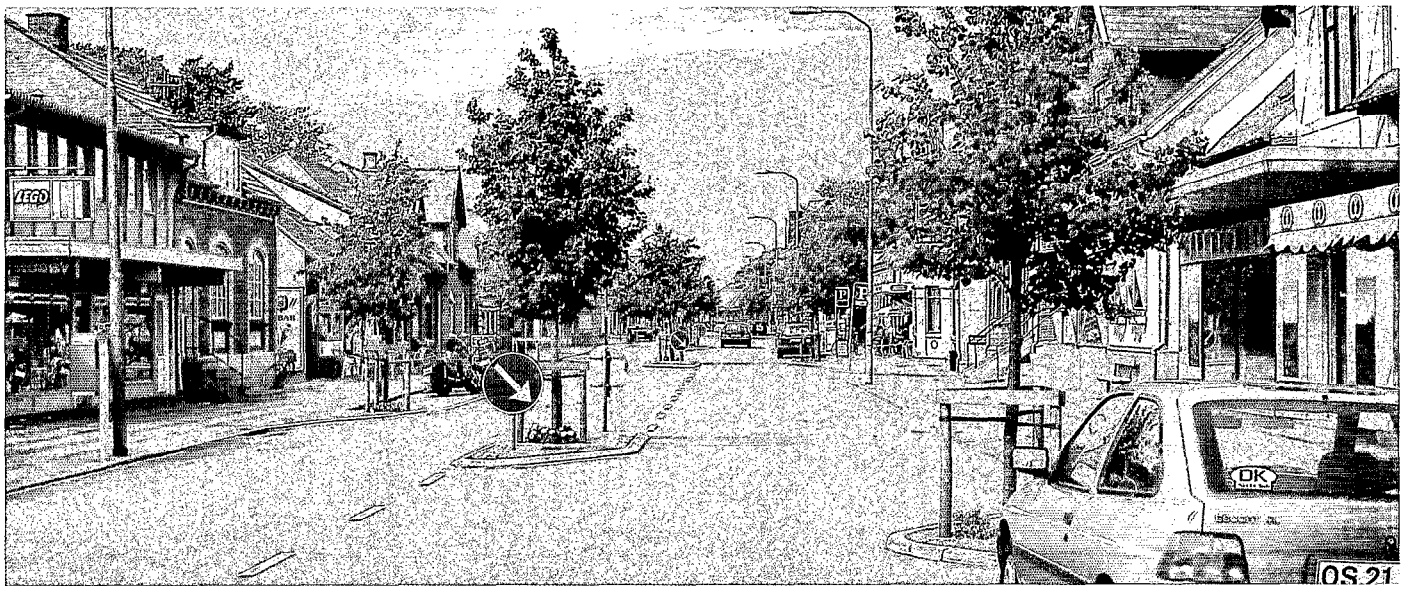
At the town gate the cycle tracks start, and the carriageway is narrowed down visually.

The roadside reservation shields off the parking bays and also helps to define space.

	Before	After
	(1984)	(1988)
Car traffic	3,000-4,500 vhl/24 hrs	3,400-5,300 vhl/24 hrs
Speed specified by signs	60 km/h	50 km/h
Mean speed, both directions	(1984)	(1989)
- point	65 km/h	-
- point 1 north	-	58 km/h
- point 2 midtown	-	57 km/h
- point 3 south	-	55 km/h
Accidents	(1980-84)	(1987-91)
- total	1.6 accidents per year	1.2 accidents per year
- involving personal injury	1.4 accidents per year	0.8 accidents per year

Sources: (39) and County of Western Sealand.

Municipal Road through Tarm



After the construction of a bypass west of Tarm the central 600 m of the former through road, Storegade, have been converted to an environmentally adapted through road, and four conspicuous town gates have been erected on the approach roads. The conversion is an example of an inexpensive, but well-functioning scheme, and has contributed to lower car speeds and an improved visual environment in the town.

Road authority	Egvad municipality
Project scope	600 m highway and 4 gates
Inaugural year - highway - gates	 1990 1991
Costs	DKK 1.3 m

The Town

Tarm, the largest town in Egvad municipality, stands a few kilometers south of Skjern in Ringkjøbing county, on route 11 between Holstebro and Varde. Tarm has about 4,000 inhabitants, and according to the regional plan is envisaged to grow, together with Skjern, into one of the 7 regional centres of the county.

The old through road cuts its way approximately 1.5 km through the town. The middle 600 m, Storegade, constitute the main shopping street.

The Background

When the last stage of the bypass west of Tarm was inaugurated in 1989, Storegade was declassified from a highway to a municipal road, and the traffic intensity fell from 8,500 to 6,400 vehicles per day.

The risk that the smaller traffic volume should result in higher speed and the desire to improve traffic safety and the visual environment inspired the municipality to decide to convert the road according to the principle of environmentally adapted through traffic.

Planning

In 1987 a traffic calming plan was prepared for the town of Tarm. The plan defined Storegade as a primary traffic road with speed reduction.

The planning was continued in 1988/89 through the drafting of a new plan for the town centre. In this connection the design principles for Storegade were discussed and determined.

In 1989 an outline design for road conversion was prepared, and the reconstruction and inauguration took place in 1990.

The four gates that indicate the transition between country and town were planned later and inaugurated in 1991.

Design

The design for Storegade includes roadside reservations, traffic islands, staggerings, zebra crossings, and changed road surfaces in two intersections.

Previously the road had 2 lanes with parking on one side. By means of road-

side reservations and traffic islands a number of staggerings have now been created, and parking takes place alternately on the two sides. The kerbs have not been moved and the cross-section still includes 2 x 4.25 m carriageway lanes and 2 m for parking. Thus, the total number of parking bays has not been reduced.

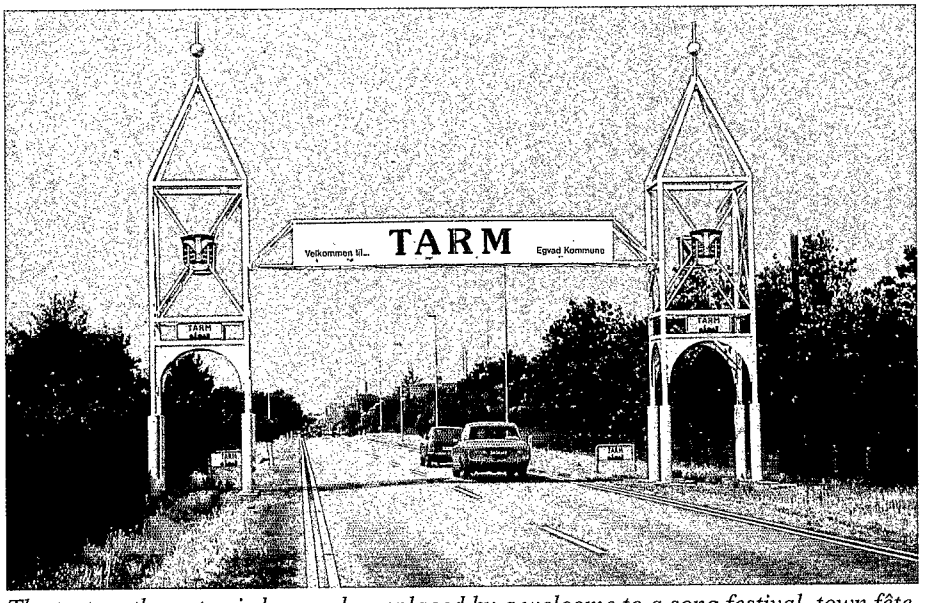
No cycle tracks have been provided, but two zebra crossings have been established in addition to the two existing. All four zebra crossings are combined with a traffic island, and the first and the last of the crossings are equipped with yellow warning lights ("Toronto").

In the intersections Storegade/Nygade and Storegade/Torvegade/Skolegade the asphalt road surface has been replaced by brown concrete paving stones.

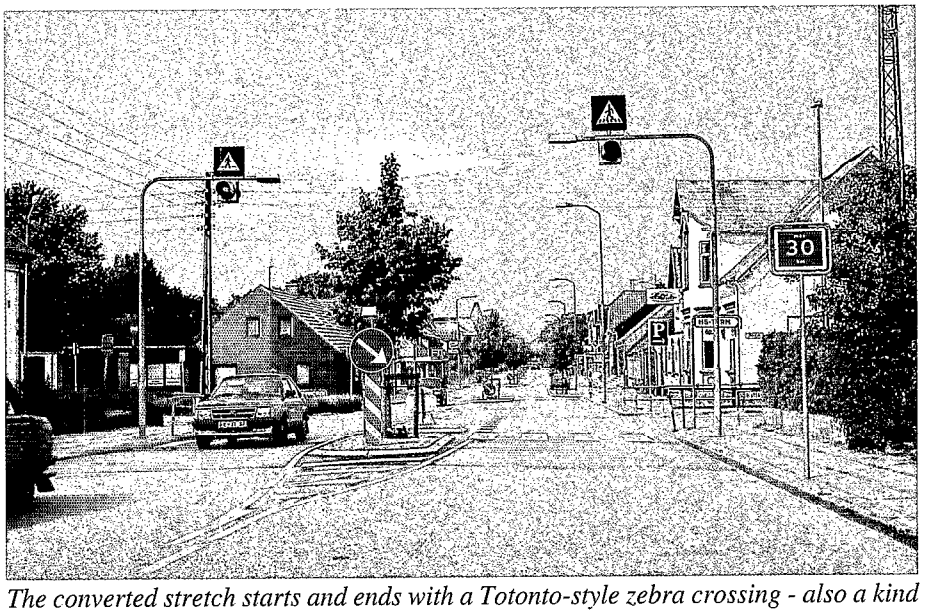
All islands are paved with granite sets and planted with 4-5 m tall lime trees.

The stretch is marked with signs recommending a maximum speed of 30 km/h.

Each gate consists of two pointed, steel lattice towers connected by a transverse, lattice girder. The towers are illuminated by flood-lights placed on the ground.



The text on the gate girder can be replaced by a welcome to a song festival, town fête, or market.



The converted stretch starts and ends with a Totonto-style zebra crossing - also a kind of "gate".

Results

No other changes of the traffic intensity than those caused by the opening of the bypass have been recorded.

Car speeds have been measured at 4 points before and after the conversion. Points 1 and 2 were placed between the staggerings, point 3 close to a staggering, and point 4 some 200 m outside the converted stretch. Depending on the measuring point, speed reductions between 3 and 7 km/h were recorded.

	Before	After
Car traffic	(1988)	
- before bypass	8,500 vhl/24 hrs	-
- after bypass	6,400 vhl/24 hrs	-
Speed specified by signs	50 km/h	30 km/h
Mean speed both directions	(1989)	(1991)
- point 1 north	39 km/h	36 km/h
- point 2 midtown	38 km/h	34 km/h
- point 3 midtown	44 km/h	37 km/h
- point 4 south	56 km/h	52 km/h
Accidents	(1985-89)	(08.90-08.92)
- total	0.8 accidents per year	1.0 accidents per year
- involving personal injury	0.6 accidents per year	0.5 accidents per year

Egvad municipality. Accidents: VDL. Speeds: Danish Road Directorate.

Highway through Skægkær

In Skægkær the through highway has been environmentally adapted by means of gates, divided tracks and a central, granite-set reservation. A certain reduction of car speeds and better conditions for light road users have been achieved.

The Town

Skægkær is situated in Århus county around highway 617 between Silkeborg and Viborg. The town has about two hundred inhabitants, a school, a grocery store, and a grill bar. In the middle of the town the highway is intersected by the road between Sinding and Sejling.

Road authority	County of Århus
Project scope	650 m highway
Inaugural year	1988
Costs	DKK 4.1 m

The Background

In the beginning of the 1980s cycle tracks were established along the highway north from Skægkær, and in 1986/87 from Skægkær south to Balle at Silkeborg. That left only the stretch through Skægkær, where it would be necessary to expropriate land if space were to be provided for tracks.

During a petition in 1985 120 people had expressed their wish to have traffic conditions improved in Skægkær, and the school formulated concrete proposals for improvements.

In 1987 it was decided that cycle tracks should be established through Skægkær in combination with other measures that would further improve the traffic environment.

Planning

A traffic planning consultant prepared an outline design for environmentally adapted through traffic with an emphasis on speed reduction.

Against this background the county worked out a detail design which in principle followed the outline design, but with a number of changes with respect to the traffic flow and resource constraints. Changes included larger areas to accommodate large vehicles, omission of trees in the central reservation, longer spacing between the trees in the gate, and omission of a zebra crossing.

The scheme was implemented in 1988.

Design

At both ends of the town a gate has been established consisting of a central island, trees, and urban zone signs. Having crossed three sets of rumble strips, drivers approaching the town meet an "avenue" comprised of 2 x 12 trees. The first six pairs of trees are withdrawn from the carriageway, whereas the next six pairs have been planted

closer together to create the impression of a narrowing.

To emphasize the gate effect shorter lamp posts have been utilized here than on the rest of the stretch.

Where the trees are closest to the carriageway, the cycle tracks have been put on the far side from the carriageway.

Through the town, from gate to gate, runs a slightly cambered, granite-set band, 1.5 - 3.0 m wide. The carriageway lanes have been reduced from 4.0 to 3.3 m.

In the intersection in the centre of the town the granite-set band is interrupted, and traffic islands and a short left-turn lane for drivers from the south have been established. One of the islands is a waiting zone for crossing pedestrians.

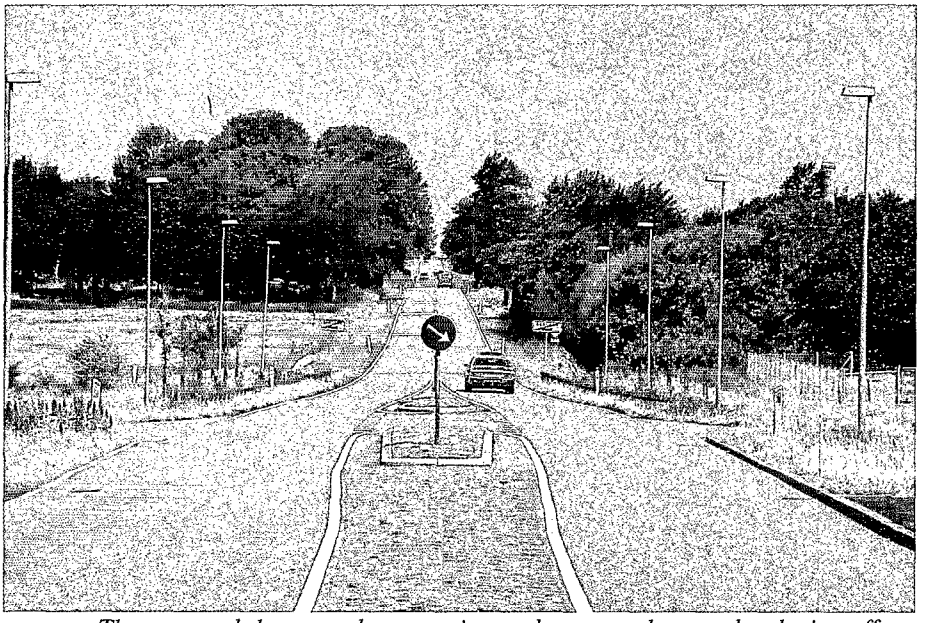
Previously, school pupils from the southern surrounding area had to cross the highway in the central intersection. Today, at the traffic island of the southern gate, there is a path crossing, connected to the local road behind.

At the bus stops near the central intersection narrow waiting platforms have been constructed between the bus laybys and the cycle tracks. As an extension of one of the bus stops, in front of the grill bar, a short parking lane has been provided.

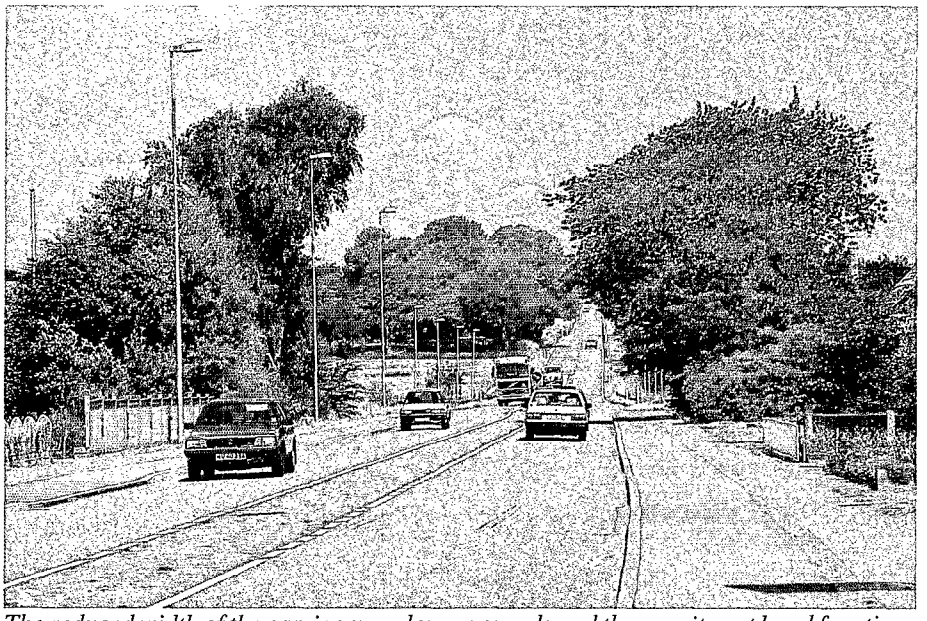
Results

From before to after the conversion traffic intensity has increased slightly more than the general traffic increase over the same period, and thus seems to be unaffected by the change.

The average car speed has dropped from 63 to 59 km/h. However, as the speed limit indicated by signs has been lowered from 60 to 50 km/h, now 88%, compared with 59% before, exceed the speed limit.



The gate and the central reservation underscores the speed reducing effect.

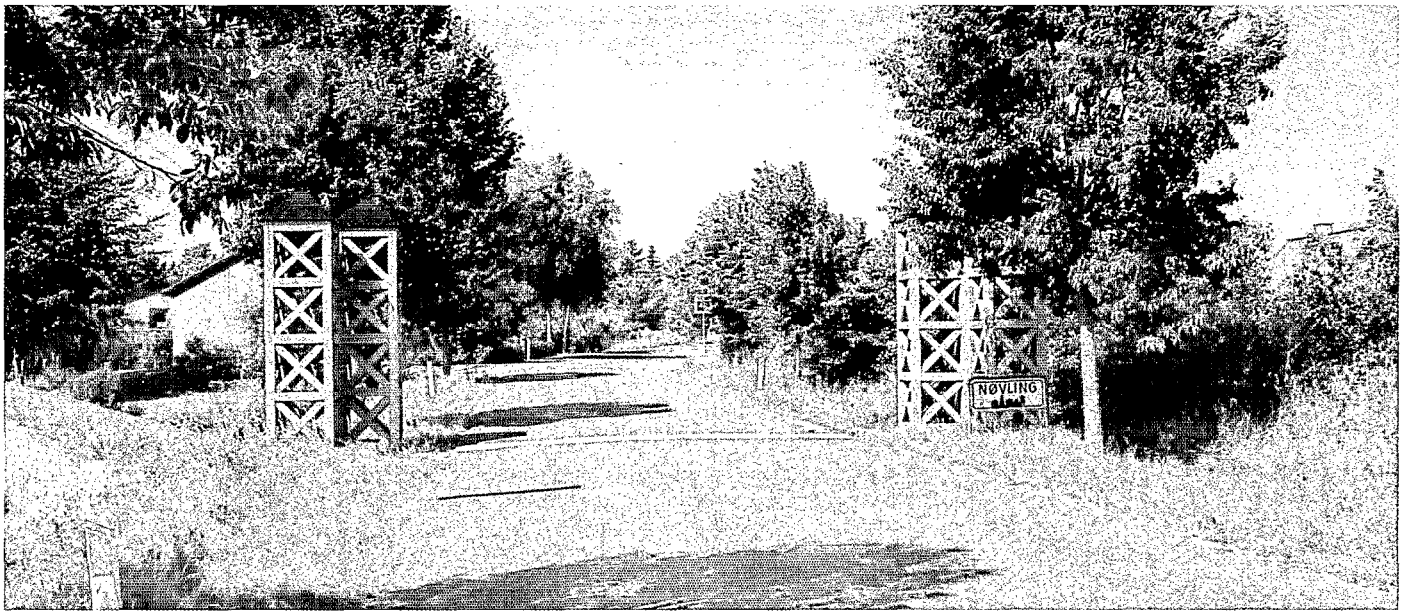


The reduced width of the carriageway lowers speeds and the granite-set band functions as a waiting zone for left-turning cars.

	Before	After
	(1987)	(1989)
Car traffic	5,400 vhl/24 hrs	6,100 vhl/24 hrs
Bicycle traffic	(1981)	
	110 vhl/24 hrs	-
Speed specified by signs	60 km/h	50 km/h
Mean speed/share >70 km/h,	(1986)	(1990)
at point, both directions	63 km/h/26%	59 km/h/14%
Accidents	(1984-89)	(1991)
- total	3.8 accidents per year	2.3 accidents per year
- involving personal injury	2.6 accidents per year	1.7 accidents per year

Sources: County of Århus. Accidents: VDL.

Municipal Roads through Nøvling



Nøvling to the south of Aalborg used to be characterized by much through traffic, much heavy traffic, and high speeds. Today there are humps and town gates, car speeds have been reduced, and the inhabitants' feeling of security has been increased.

The Town

Nøvling is situated in Aalborg municipality, immediately south of the city of Aalborg, around the municipal roads between Aalborg and Gunderup, and between Gistrup and Ferslev.

The town has 350 inhabitants, a school, sports grounds, and a shop.

The Background

From some areas in the city of Aalborg the road through Nøvling is a short-cut to the highway towards Hadsund. For many years this has caused problems of through traffic, particularly heavy traffic, at much too high speeds. In 1989 an analysis showed that 69% of all the cars entering the town were through-going.

As the school lies to the west of Brådalvej the parents living in the eastern part of the town especially felt insecure about the children's way to school.

Therefore, in 1988, Aalborg municipality decided that a traffic calming scheme should be implemented.

Planning

Initially, the technical administration of the municipality worked out a proposal that included gates on the 4 approach roads to the town, 5 humps, 2 raised areas, and a short traffic island.

The proposal was published and gave rise to many positive and negative comments. Consequently, a public meeting with high participation was held where it was decided, by show of hands, to carry on with the traffic calming project.

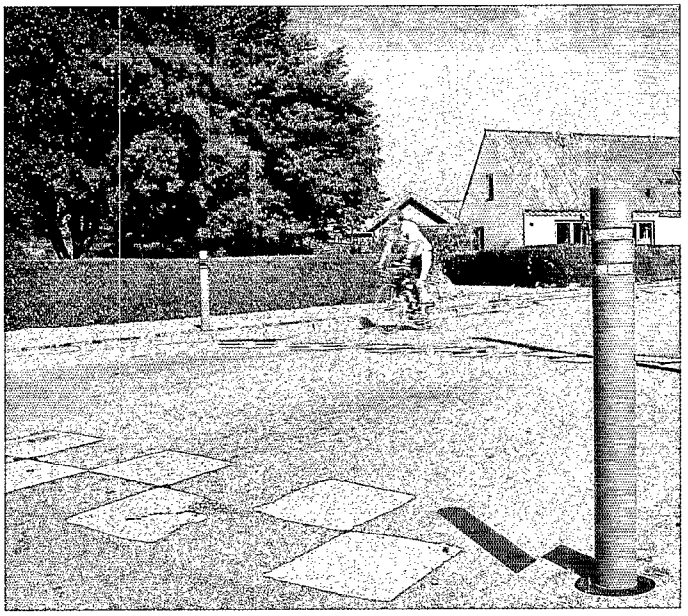
After the conversion in the spring of 1990, and following the traffic count and a questionnaire study, a new public meeting was held in the autumn. This meeting resulted in the establishment of two extra humps.

Design

All 7 circular humps are designed for 40 km/h, i.e. with a height of 10 cm and a chord length of 6.5 m. The humps cover the entire width of the carriageway, so that cyclists also have to cross them. To indicate them visually red bollards have been placed at the kerb in the four corners, and the humps are also marked by the usual chess board road marking.

There are raised areas on two locations, i.e. on Nøvlingvej in front of the grocer's and on Brådalvej just before Nøvlingvej. The former is supplemented at both ends by two roadside reservations with trees so that the carriageway is narrowed down and the raised area is visually emphasized.

Road authority	Aalborg municipality
Project scope	4 gates, 7 humps, 2 raised areas, and central island
Inaugural year	1990
Costs	DKK 0.6 m



The raised area is clearly indicated.

It is easier to get to and from the grocer's.

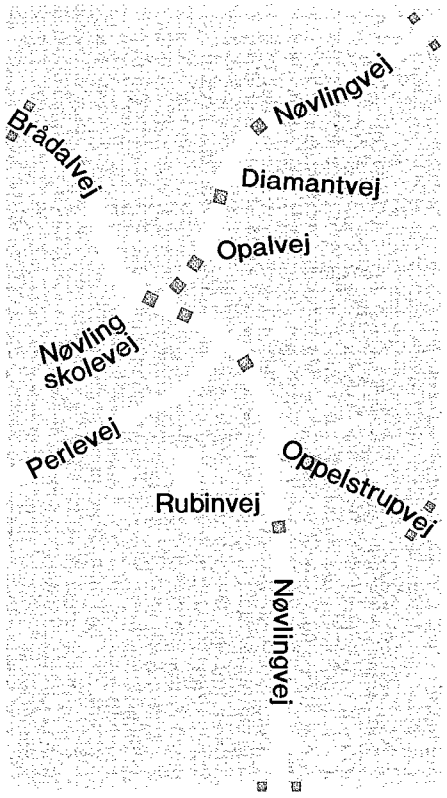
On Nøvlingvej in the north-western end of the town a traffic island has been established in connection with a bus stop, partly to reduce speeds, partly to facilitate road-crossing for the pedestrians.

Town gates have been provided on the four roads entering the town. One gate consists of two blue double towers in a timber lattice construction and with pyramidal roofs. The north-western gate has been removed somewhat from the town out of respect for the church, which stands on the western side of the road.

Results

The conversion has not changed the traffic intensity. Car speeds, however, have dropped by between 5 and 15 km/h at the humps and by 5 km/h at the traffic island.

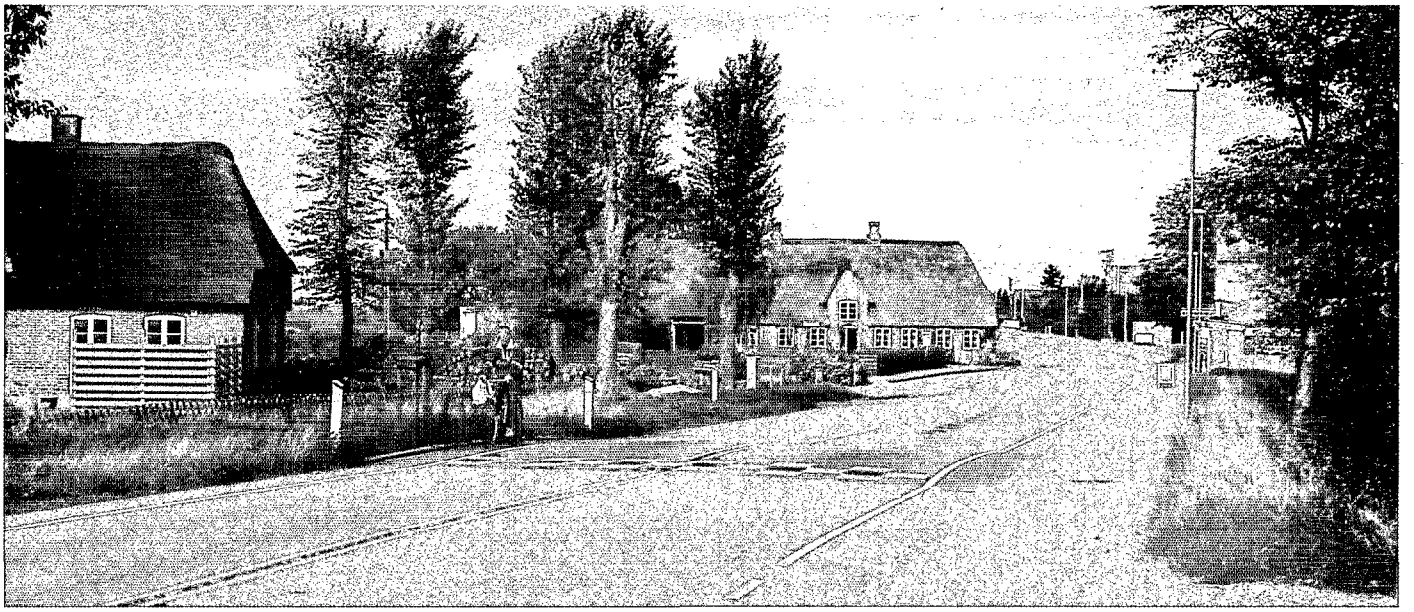
After the conversion a small questionnaire interview was conducted among the inhabitants of Nøvling. It demonstrated that there was general satisfaction with the scheme, both with the individual elements and the effects *(71)*.



	Before	After
Car traffic	(1989)	(1990)
- Brådalsvej	1,860 vhl/24 hrs	1,940 vhl/24 hrs
- Nøvlingvej, north	1,060 vhl/24 hrs	1,210 vhl/24 hrs
- Nøvlingvej, south	1,170 vhl/24 hrs	1,180 vhl/24 hrs
- Oppelstrupvej	540 vhl/24 hrs	530 vhl/24 hrs
Speed specified by signs	50 km/h	40 km/h
Mean speed/85% quantile at point, both directions	(1989)	(1990)
- Brådalsvej	54/62 km/h	49/56 km/h
- Nøvlingvej, north	67/76 km/h	62/72 km/h
- Nøvlingvej, north	60/68 km/h	57/64 km/h
- Nøvlingvej, midtown	55/62 km/h	40/44 km/h
- Nøvlingvej, midtown	58/64 km/h	47/52 km/h
- Nøvlingvej, south	56/68 km/h	42/48 km/h
- Oppelstrupvej	58/68 km/h	46/50 km/h
Accidents	(1986-88)	(06.90-05.92)
- total	1.0 accidents per year	0.5 accidents per year
- involving personal injury	0.7 accidents per year	None

Source: Aalborg municipality.

Highway through Sdr. Sejerslev



By establishing seven circular humps on the highway through Sdr. Sejerslev the county of Southern Jutland has achieved a considerable speed reduction. An inquiry among the town inhabitants reveals widespread satisfaction with the scheme.

The Town

Sdr. Sejerslev is situated in Højer municipality in Southern Jutland, 3 km from the tidal flats and 10 km north of the Danish-German border. The town has about 800 inhabitants and some industries, but no school.

Highway 543 from Højer to the north passes through Sdr. Sejerslev.

The Background

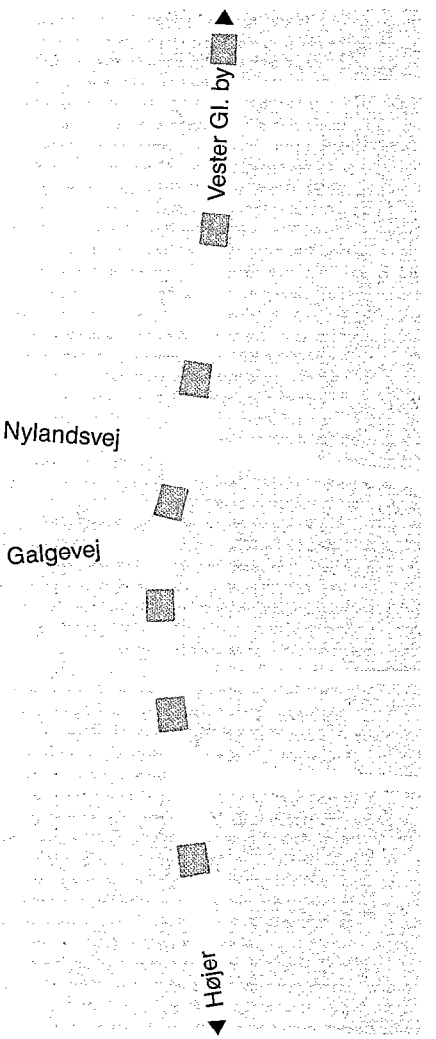
For many years the town inhabitants had been bothered by the through traffic, its volume (up to 1,600 vehicles per day), and especially the speed (66 km/h on average), and they had expressed the wish for improvements for a long time.

Planning

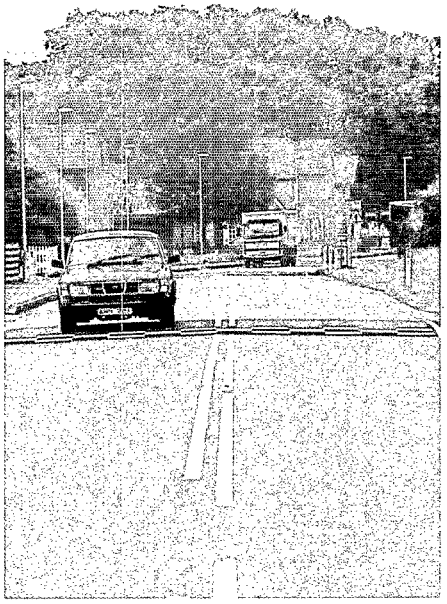
The initiative of the county of Southern Jutland in Sdr. Sejerslev should be seen as part of the county's general efforts to improve the traffic environment in the small towns of Southern Jutland by fairly economic methods.

Since 1989 town gates have been constructed at the entrances to a considerable number of towns, and inexpensive speed reducing schemes have been implemented both in Sdr. Sejerslev and in Sjølund south of Kolding.

In Sdr. Sejerslev the planning resulted in a project that was accepted in 1990 and implemented towards the end of the same year.



Road authority	County of Southern Jutland
Project scope	7 humps Renovation of lighting
Inaugural year	1990
Costs	DKK 0.2 m



The distance between the humps varies.

Percent of respondents	+	0	÷
General impression is good/bad	83	12	5
As a road user I find that			
- traffic safety has been improved/impaired	95	5	0
- the design of the humps is appropriate/inappropriate	79	0	21
- the spacing between the humps is appropriate/inappropriate	71	5	24
- the road marking is appropriate/inappropriate	86	2	12
- lighting conditions are good/bad	60	38	2
As an inhabitant I find that			
- the through traffic has decreased/increased	7	93	0
- car speeds have decreased/increased	86	14	0
- traffic-related noise has decreased/increased	29	49	22
- security for pedestrians and cyclists has been improved/impaired	98	2	0
- the appearance of the road has been improved/impaired	40	55	5

The inhabitants' evaluation of the project. Source: County of Southern Jutland

Design

7 humps have been established at intervals varying between 70 and 120 m due to the location of side roads etc. The humps have been built as circular humps and are designed for 50 km/h, i.e. with a height of 10 cm and a chord length of 9.5 m.

The circular humps, which cover the entire width of the carriageway, are marked by the usual chess board pattern.

The stretch used to be marked with 60 km/h signs. This has now been changed to ordinary urban zone signs at the town limits which means a 50 km/h speed limit.

Results

Both before and after the establishment of the humps, speed measurements have been made with radar pistol at three points on the stretch. The measurements show a fall in average speed of no less than 32 km/h. The highest measured speed has fallen from 81 to 57 km/h, and even though the maximum speed limit has been lowered by 10 km/h, only 3% drive too fast today compared with 68% previously.

In addition a little questionnaire interview has been conducted among the inhabitants. 42 questionnaires were returned and demonstrated that there was a very large proportion of positive attitudes towards the scheme. People feel that speeds have been reduced, that traffic safety has been improved, that the general impression is satisfactory, and that there are many other positive effects associated with the project.

Today she only drives at 34 km/h.

	Before	After
	(1989)	(1991)
Car traffic	1,600 vhl/24 hrs	1,800 vhl/24 hrs
Bicycle traffic	-	(1991) 12 vhl/24 hrs
Speed specified by signs	60 km/h	50 km/h
Mean speed/share > permitted at point, both directions	(1990) 66 km/h/68%	(1992) 34 km/h/3%
Accidents	(1984-89)	(1991)
- total	0.3 accidents per year	0.0 accidents per year
- involving personal injury	0.3 accidents per year	0.0 accidents per year

Sources: County of Southern Jutland. Accidents: VDL.

Highway at Dybbøl Hill

The road authorities of the county of Southern Jutland are rebuilding the highway between Dybbøl and Sønderborg. The scheme constitutes an all-encompassing solution including safer traffic conditions, a better arboreal environment, and pleasant surroundings for both the inhabitants and visitors. The scheme shows great veneration for a nationally protected area.

The Area

The area to the east of Dybbøl village is of unique value, both historically and scenically.

At Dybbøl Hill there is a wide view over the landscape with the historic memorials to the Slesvig wars and farther across the Bay of Sønderborg and Broagerland.

Many tourists visit the area and pause mainly at Dybbøl Mill, but also at the ramparts and the common graves.

The Road

The highway between Dybbøl (2,000 inhabitants) and the largest town in Southern Jutland, Sønderborg (25,000 inhabitants), runs through the area and thus passes closely by some of the most significant historic sights.

For a long time the road had been an important connection to Flensborg and today it is a much used approach road to Sønderborg. Due to the massive traffic volume (annual traffic per day, 1990: 6,500), rather poor sight conditions, and too high speeds, quite a few accidents have happened on the road (44 accidents recorded by the police in 1982-89, of which 30 involved personal injury).

In the middle of the previous century the road was paved and an avenue of elms was planted. In 1987 the avenue became a protected amenity, but already at this time only about half of the originally 300 trees were left - and were in poor condition. Most of them suffered from fungus and many were dying. And due to the death of trees the impression of an avenue had disappeared on many stretches.

Road authority	County of Southern Jutland
Project scope	approx. 2 km highway
Inaugural year	
- 1st stage	1991
- 2nd stage	1992
- The total project	1993
Costs	
- The total project	DKK 23 m

The Background

In 1986 the county council of Southern Jutland decided that the old elms were to be replaced by new ones. At the same time a new visitors' centre was planned, to be located north of the highway, between Dybbøl Mill and the King's rampart.

In this connection the wish was also to improve access and parking conditions, among other things by establishing a new car park to the north of the road to replace the one to the south and by extending the car park in front of Dybbøl Mill and reserving it largely for buses.

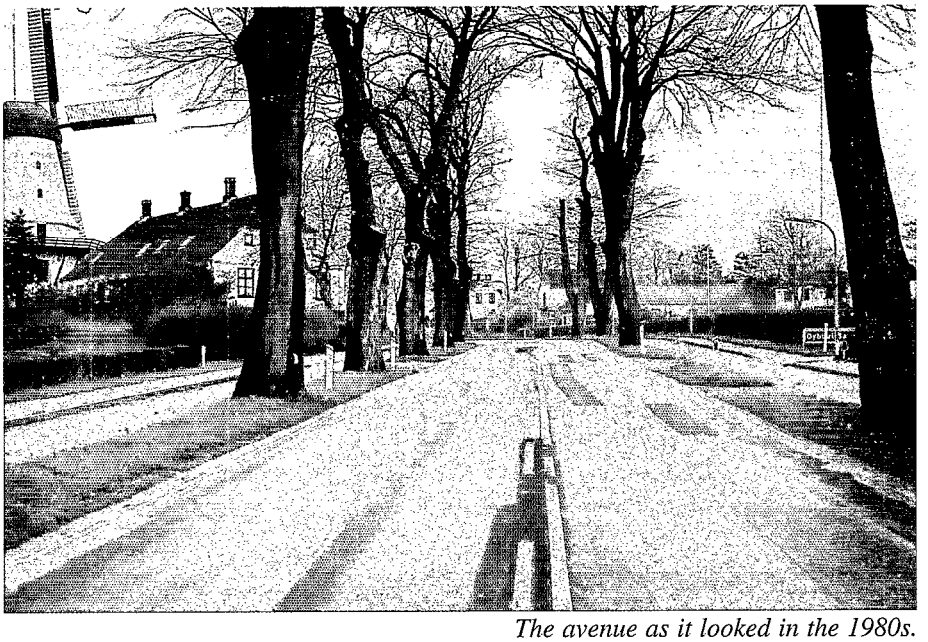
Last but not least a traffic calming of the road was urgently necessary.

Planning

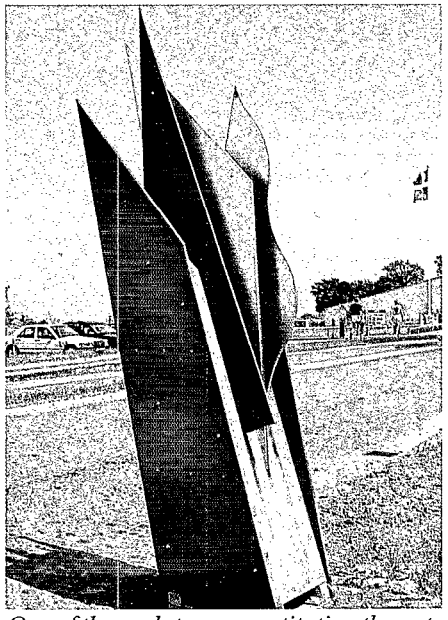
To achieve the best possible total solution the road authorities of Southern Jutland county set up a working party in 1990, consisting of representatives of the authorities and interest groups involved. The objective of the working party was to work out an outline design for the renewal of the avenue, the road section, and the car parks.

The result was a scheme which unites modern planning considerations with regard to historic and cultural values *(51).*

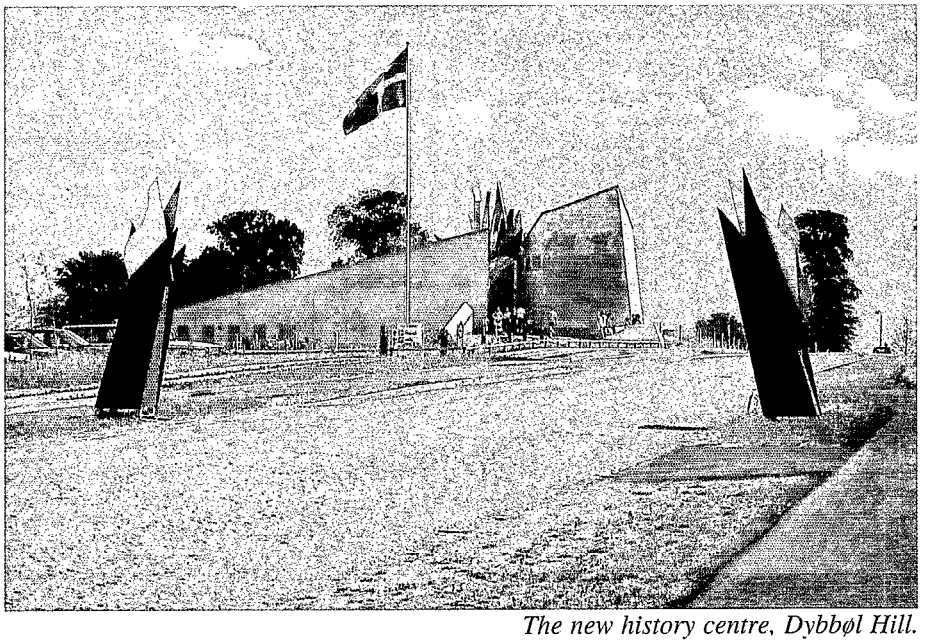
The cobbled avenue from the 1800s.



The avenue as it looked in the 1980s.

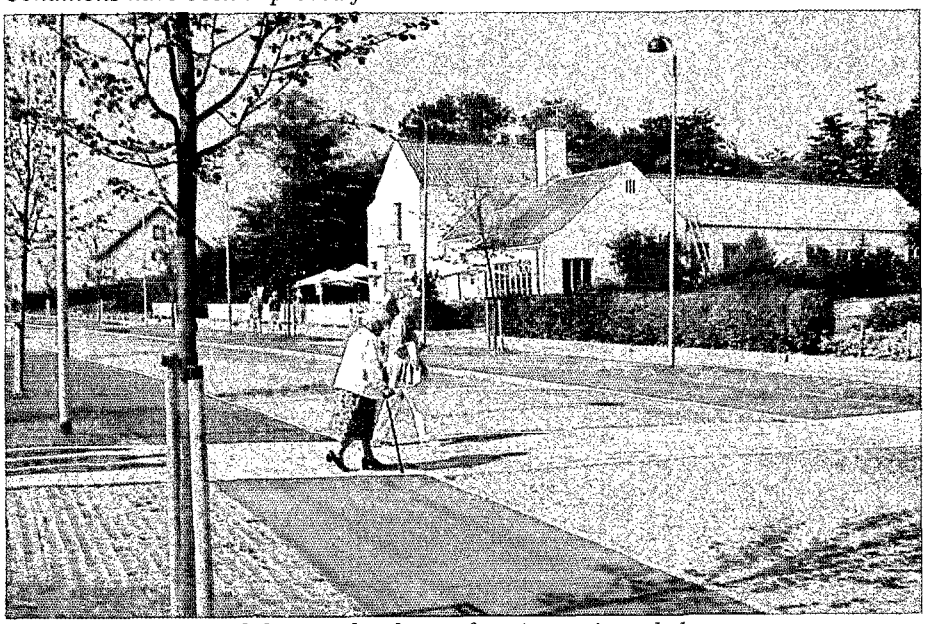


One of the sculptures constituting the gate.



The new history centre, Dybbøl Hill.

Conditions have been improved for two-wheelers.



The path crossing and the speed reducers function as intended.

The outline and detail design for the road section were prepared through 1990-91. In 1991 the road works were implemented from the common graves to Dybbølsten, followed, in 1992, by the remaining section plus the planting of trees. In 1993 the total project was finished by laying the wearing surface.

Design

The road scheme includes

- warning sections,
- a gate,
- narrowing of the carriageway,
- cycle tracks and sidewalks,
- zebra crossings on raised areas, and
- an avenue of lime trees

At the western end of the stretch, two almost 100 m long warning sections have been established spaced a little more than 200 m apart, paved with granite cobbles instead of asphalt.

After the second warning section follows a short transition section, where the width of the carriageway is reduced from 7 to 6 m. The beginning of the transition section is indicated by a gate - sculptural elements placed on the verges on both sides of the road.

The following section has also been paved with granite cobbles, and cycle tracks, grass verges, and flag-paved

Only a short time after the planting, the avenue is already beautiful.

sidewalks have been provided on both sides.

On three locations, i.e. in front of the new visitors' centre, to the east of this, and in front of Dybbøl Mill, speed reducers have been constructed in the form of zebra crossings on 15 m long raised areas. Also the raised areas are paved with granite cobbles.

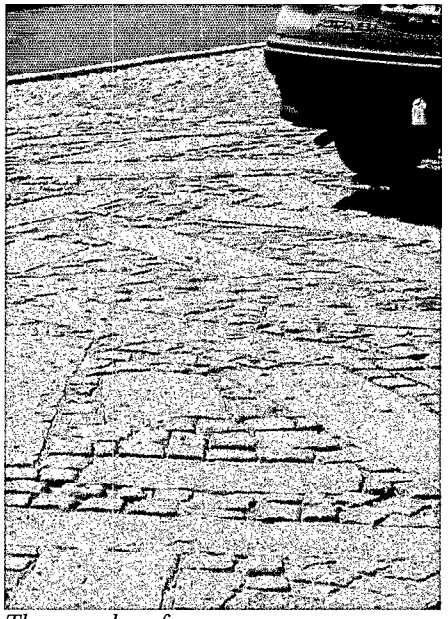
From Dybbøl Mill towards the east to Aabenraavej the asphalt carriageway has been retained, although narrowed down to a width of 6.5 m. Also here there are cycle tracks, grass verges, and flag-paved sidewalks.

The existing road trees have been removed and a new avenue of 5.5 m tall lime trees have been planted at intervals of 15-20 m.

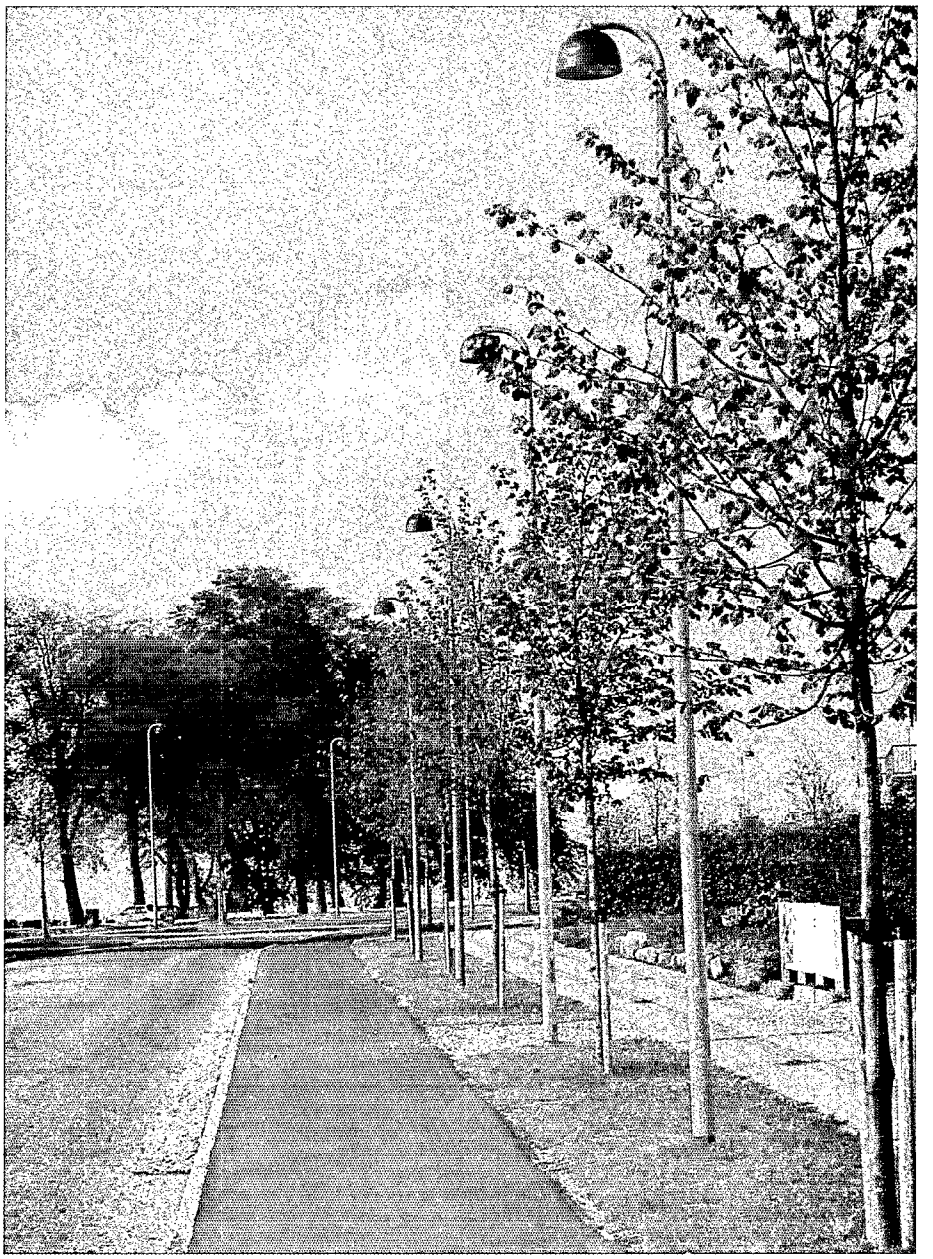
The road lighting has been modernized on the whole stretch between the common graves and Aabenraavej so that all traffic areas are fully illuminated.

Results

Already today, before the final completion, the project appears as a beautiful unity of road design techniques and plantings. Better sight conditions have been achieved, and the narrowed cross-section and the speed reducers have lowered speeds as intended.



The paved surface.

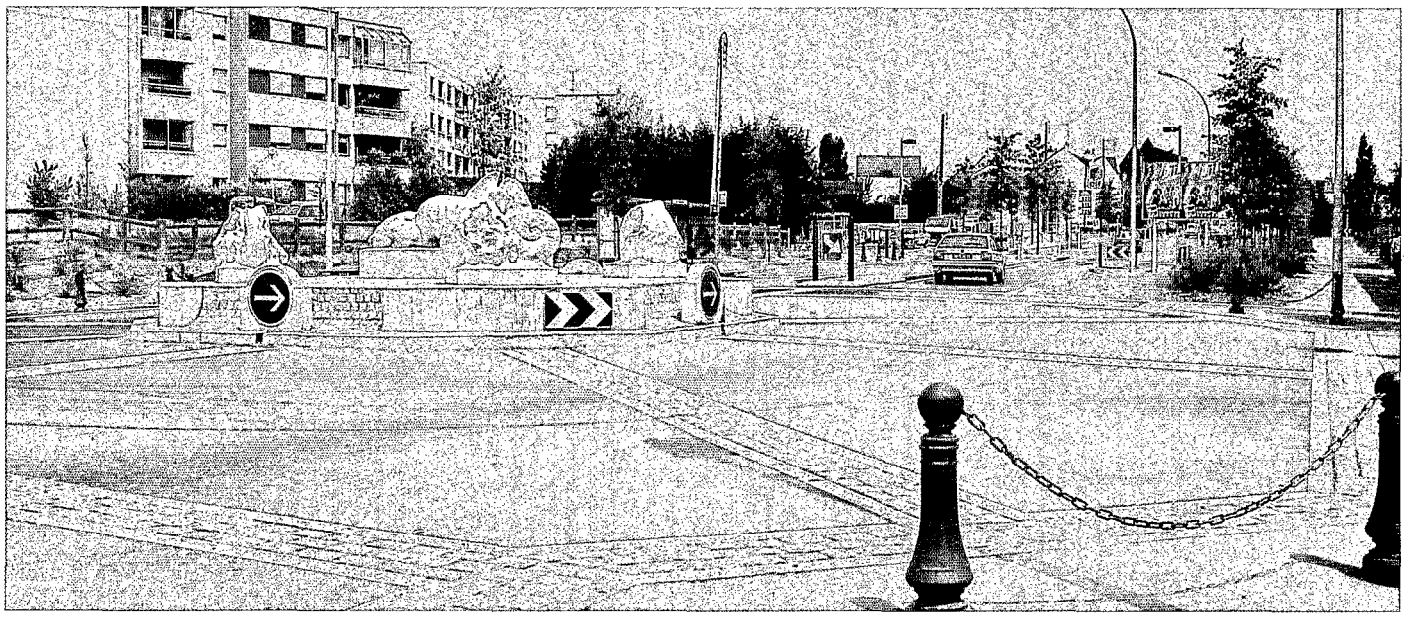


The new lighting fittings.

	Before (1989)	After (1992)
Car traffic	6,500 vhl/24 hrs	4,200 vhl/24 hrs
Speed specified by signs	60 km/h	40 km/h
Mean speed at point, both directions	(1990) 67 km/h	(1992) 32 km/h
Accidents	(1982-89)	(1991)
- total	5.5 accidents per year	1.0 accidents per year
- involving personal injury	3.8 accidents per year	1.0 accidents per year

Source: County of Southern Jutland.
Reservations about after-measures due to road work.

Approach Road at Rennes, France



As part of the French government's programme "Ville plus sûre, Quartiers sans accidents" (Safer Town, Urban Areas without Accidents) one of the approach roads to Rennes has been rebuilt. A roundabout has been established together with speed reducing measures such as staggerings and changed road surfaces, and the urban environment has been further improved by objects d'art and plantings.

The Town

Rennes is situated 320 km west of Paris. It is the largest town in Brittany and the "capital" of the department of Ille-et-Vilaine. The town has about 200.000 inhabitants.

The Background

Since the mid-1970s Rennes has worked with determination to improve traffic safety. The result was a reduction of the number of accidents in the town of 40% from 1976 to 1985.

Since 1984 Rennes has been one of the towns that participate in the French government's project "Ville plus sûre, Quartiers sans accidents". The objective of the programme is to improve traffic safety and the quality of life in general, with due consideration given to the flow of traffic. The means adopted are conversions of roads, streets, and squares according to certain common guidelines *(52)*.

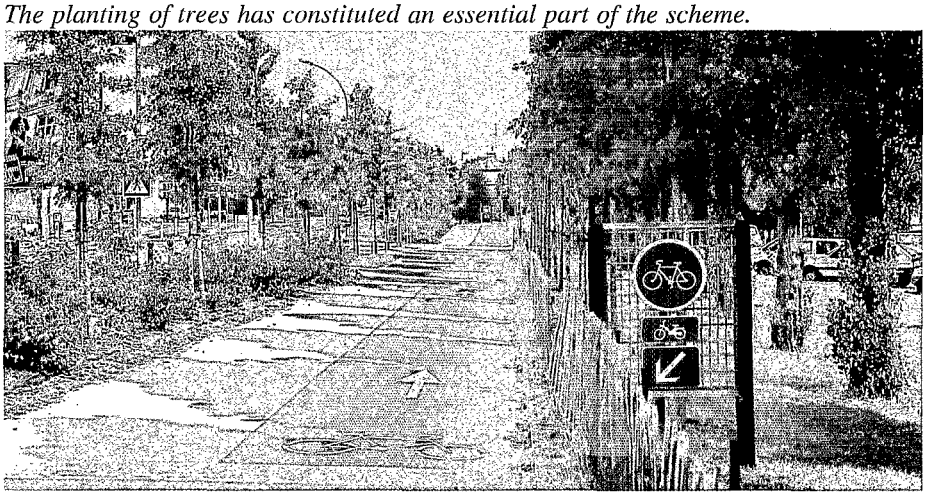
Rennes has participated with two schemes: in addition to the redesign of the southern approach to the city, Route National 137 (Rue de Nantes) described here, it has also converted a primary artery in the town, the boulevard Léon Grimault.

R.N. 137 is partly the connecting road to Nantes (to the south of Rennes), partly - and equally importantly - one of the radial approaches to Rennes from the motorway encircling the town. The road has an annual traffic per day of 12,000 vehicles and also much pedestrian traffic and many bus services. Before the conversion, speeds on the section from the motorway junction were very high, inspired by many drivers coming directly from the motorway.

Planning

As in all "Ville plus sûre" projects the planning and design work for the con-

The planting of trees has constituted an essential part of the scheme.



version has been very interdisciplinary. Engineers, town planners, sociologists have participated - and during and after the project the principle of public consultation has been emphasized.

Design

The main objective of the conversion was to lower car speeds. This was achieved by changing the road and its surroundings, which created a clear difference between the highway and the townstreet. With this objective in mind the scheme included, among other things, a pre-warning, a "gate", and a conversion of the road section after the gate.

The pre-warning is made up of cobbled bands across the carriageway, immediately at the transition from the motorway ramp to the town street.

The gate, some 100 m after the pre-warning, is a roundabout. There is only one insignificant side road junction to it, so its purpose is mainly to reduce speeds. To enhance this speed reducing effect both the central island and the carriageway of the roundabout are octagonal, and radial cobbled bands are embedded in the carriageway.

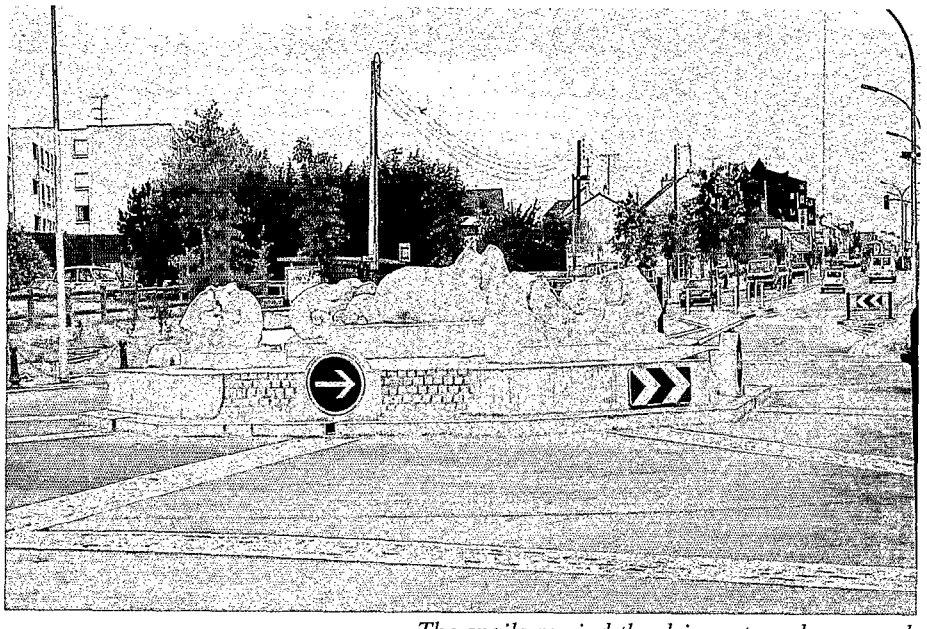
Drivers are furthermore inspired to reduce speeds by means of the sculptures placed on the central island: snails, the symbol of low speed.

On the section after the roundabout the carriageway has been staggered just before a zebra crossing.

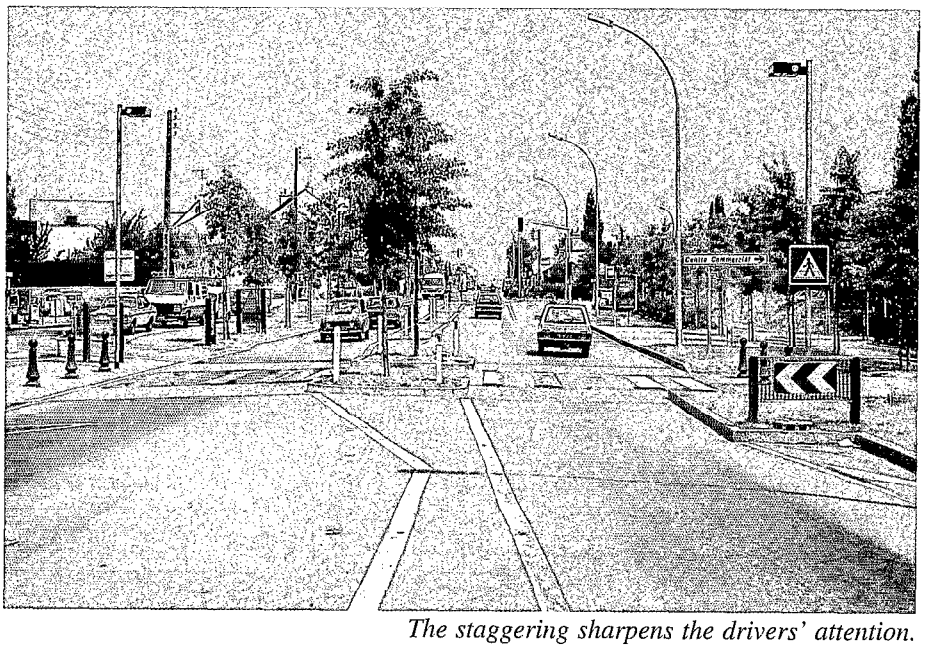
Trees have been planted in the central and in roadside reservations, and on the east side, between the carriageway and a dual cycle track, there are small sculptures.

Results

The conversion caused a considerable reduction of car speeds, and the number of accidents involving personal injury on the stretch fell from 2.4 to 1.4 on average per year.



The snails remind the drivers to reduce speed.

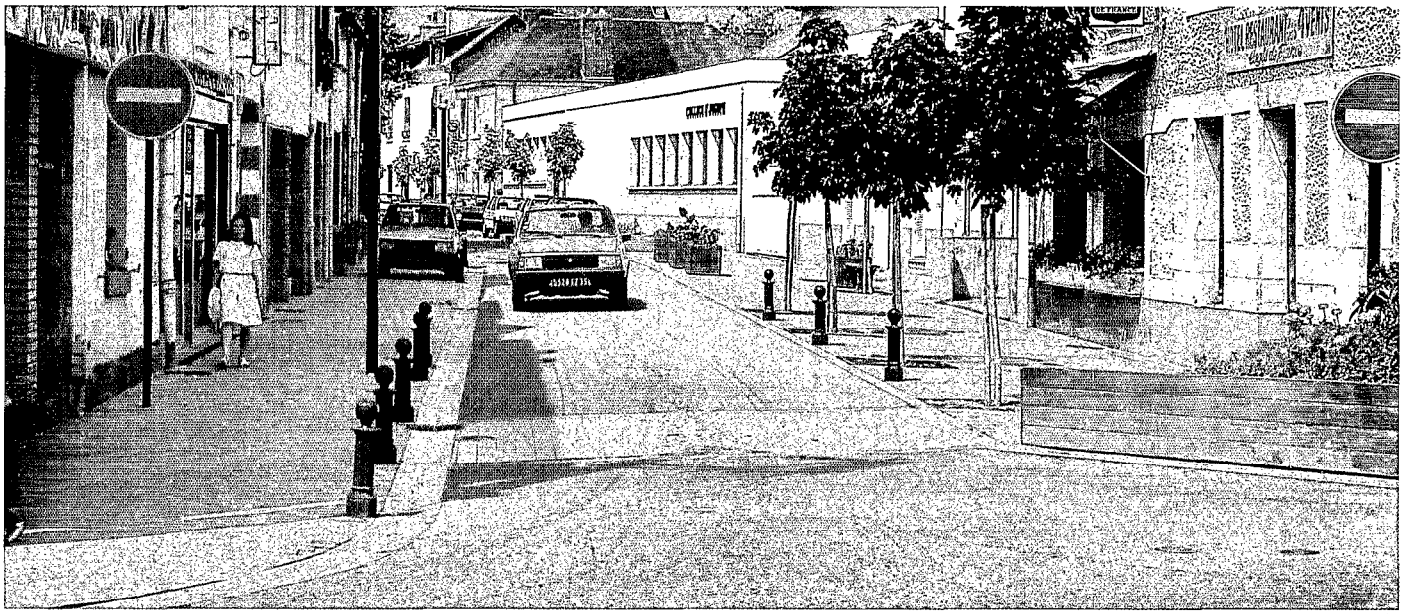


The staggering sharpens the drivers' attention.

	Before (1986)	After (1991)
Car traffic	12,000 vhl/24 hrs	12,400 vhl/24 hrs
Mean speed/share > 50 km/h at point, both directions	60 km/h/79%	(1991) 34 km/h/4%
Accidents - involving personal injury	1982-86 2.4 accidents per year	1988-91 1.4 accidents per year

Sources: CETUR, CIV.

Town Streets in Bain-de-Bretagne, France



In Bain-de-Bretagne the relief caused by the construction of a bypass has been used as an opportunity to redesign the urban traffic network considerably.

The Town

Bain-de-Bretagne is also situated in the department of Ille-et-Vilaine, but on Route National 137, 30 km to the south of Rennes towards Nantes. R.N. 137 is the main connection from Brittany via the Loire Valley to south-western France.

Bain-de-Bretagne has 5,500 inhabitants.

The Background

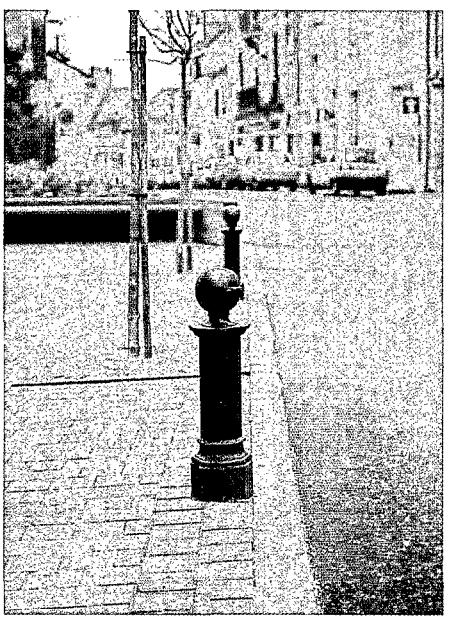
In 1986 the massive north-south going traffic through Bain was redirected via a new bypass west of the town, and thus the premises for the planning and the detail design of the urban road network were changed completely.

Until then almost 20,000 vehicles, of which were 3,000 lorries, had passed through the town every day *(72)*.

The redirection, however, not only reduced the north-south traffic, but also intensified the east-west traffic through the town's junction to the new bypass.

Planners were also aware of the potential risk of higher speeds on the less congested road.

It was therefore decided that the most important streets of the town were to be rebuilt in accordance with the intentions laid down in the "Ville plus sûre"-programme.



Planning

An interdisciplinary planning programme was started under the governance of a commission comprised of the mayor and representatives of the schools, the gendarmerie, the local chamber of commerce, the driving schools, the fire brigade, and the hospital.

As a basis for the work the commission formulated a number of objectives with great emphasis laid on the quality of life of the inhabitants. As far as traffic was concerned, this meant that it had to function, to the extent possible, on the terms of the entire urban community, as safely and securely, and with as little noise and other environmental impacts as possible.

The conversion was divided into three stages: construction of the new western approach; conversion of the old through road; and redesign of the town square, the Place de la République.

The intersection is indicated by a raised area, changed road surfaces on the ramps, and cast-iron bollards.

Design

The resulting scheme included substantial changes of road cross-sections, primarily a narrowing of the carriageway to a width of typically 6 m, and a corresponding extension of the sidewalk area and other pedestrian areas.

In several places the continuous nature of the carriageways has been interrupted visually through short stretches of paving stones instead of the ordinary asphalt. At some of the side road junctions changed road surfaces have also been utilized as a visual measure.

At other side road junctions raised areas have been established with cobbled ramps to the actual area of the intersection.

In the most important intersection of the western approach and on one other location in the town roundabouts have been built.

Parking has been significantly reorganized. In this connection cast-iron bollards have been positioned along the kerb in several places to prevent the popular French usage of parking on the sidewalk.

Quite a few trees have been planted, but otherwise the new plantings consist mainly of cribs with the flowers of the season.

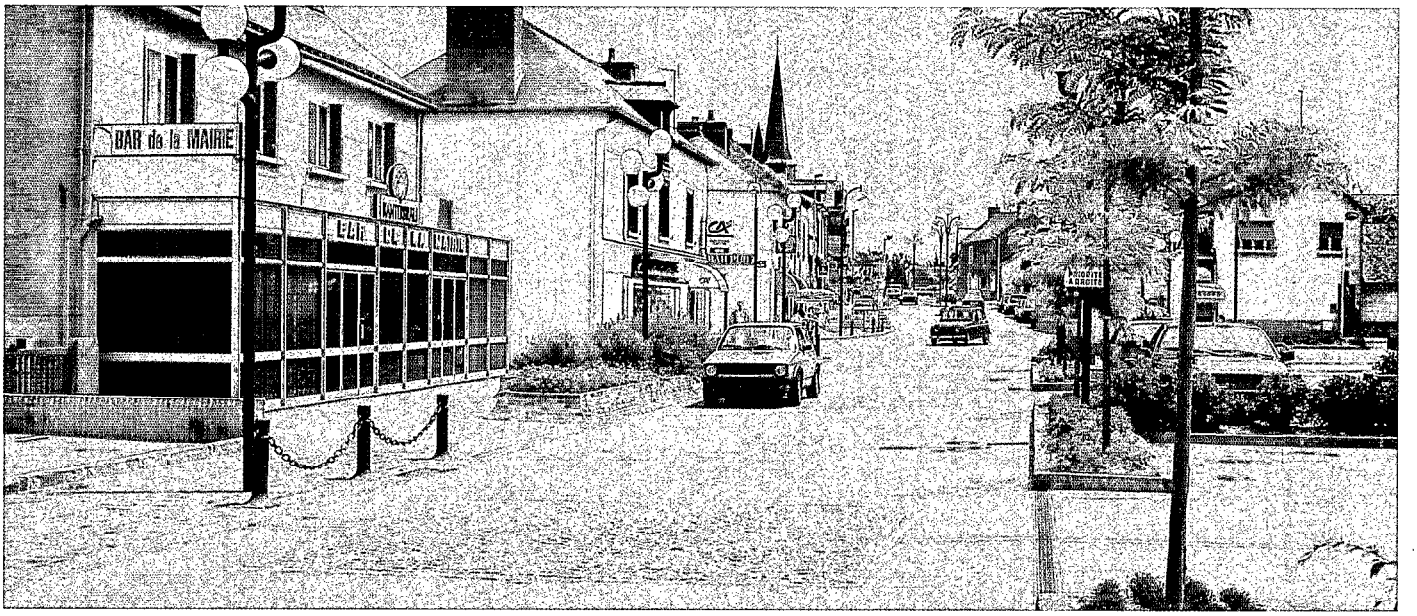
Finally, the lighting has been improved and embellished by the erection of new lamp posts.

The 6 m wide carriageway of the old highway is diversified by changed road surfaces and a raised area.

Place de la République. Sidewalks and pedestrian crossings are paved with coloured concrete flag stones, and parking is more orderly.

One of the road junctions.

Municipal Road through Chantepie, France



In Chantepie, a Rennes suburb, the main street, the Rue Nationale, has been rebuilt in order to reduce the number of cars and their speed, and with considerable consideration for the overall visual environment.

The Town

Chantepie is one of the suburbs of Rennes. It lies to the south-east of the town, on the old highway between Rennes and Angers, CD 463, outside the motorway ring around Rennes. Chantepie has 6,000 inhabitants.

The Background

In the 1970s the highway and thus Chantepie were suffering under a heavy load of through traffic. Therefore, in 1979, a bypass was built south of the town, which caused some relief.

However, the traffic soon increased and already in 1985 it had reached former levels, i.e. annual traffic per day of about 8,000 cars. In addition, the cars drove fast. Speeds of 60-70 km/h were common *(72)*.

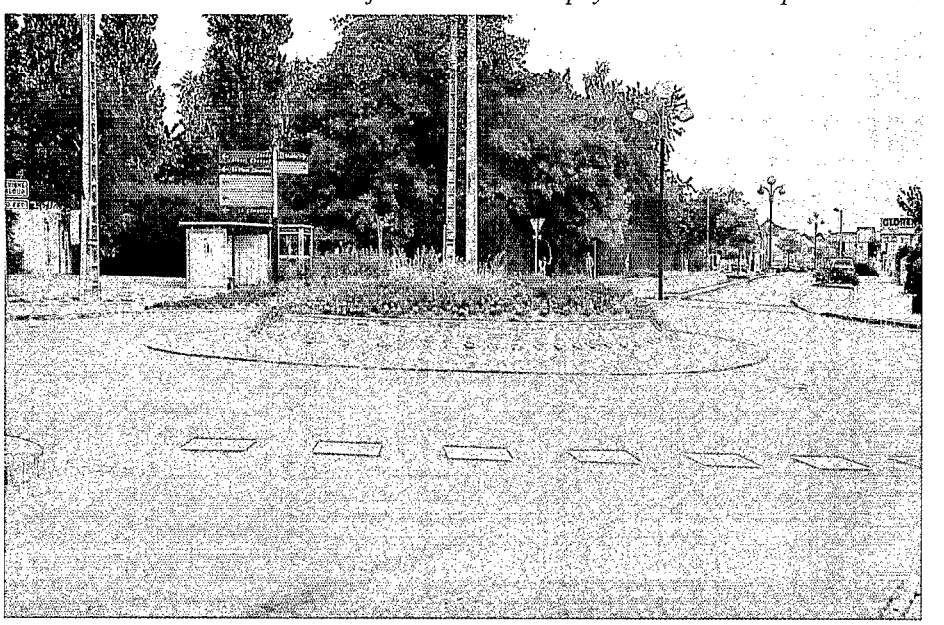
At this point in time the square in front of the town hall was about to be redesigned, and under the pressure of the growing traffic problems it was decided to make an appraisal of the whole main street as part of the central government's "Ville plus sûre" programme.

Planning

A commission was set up headed by the mayor of Chantepie and with the participation of town and traffic planners and representatives from both the police and the gendarmerie. In addition, commission members represented other groups in the town: parents, shopkeepers, pensioners, and cyclists.

Project scope	1.000 m municipal roads and gates
Inaugural year	1988
Costs	DKK 9.6 m

The roundabout at the town border functions as both a physical and visual speed reducer.



The commission was inspired by what was happening in other places, both abroad and in France, particularly in Mutzig and Rennes.

Both the professional and the non-professional members of the commission strongly emphasized that the initial studies should not only include the traffic and the road, but also the buildings along the road, so that any solution would be integrated in a co-ordinated urban architecture.

The scheme that was implemented thus aimed to reduce speeds, to direct more drivers to the bypass, and to create a prettier town *(53)*.

Design

At each end of the road a roundabout has been established with a highly raised central island and plantings that interrupt the road alignment visually.

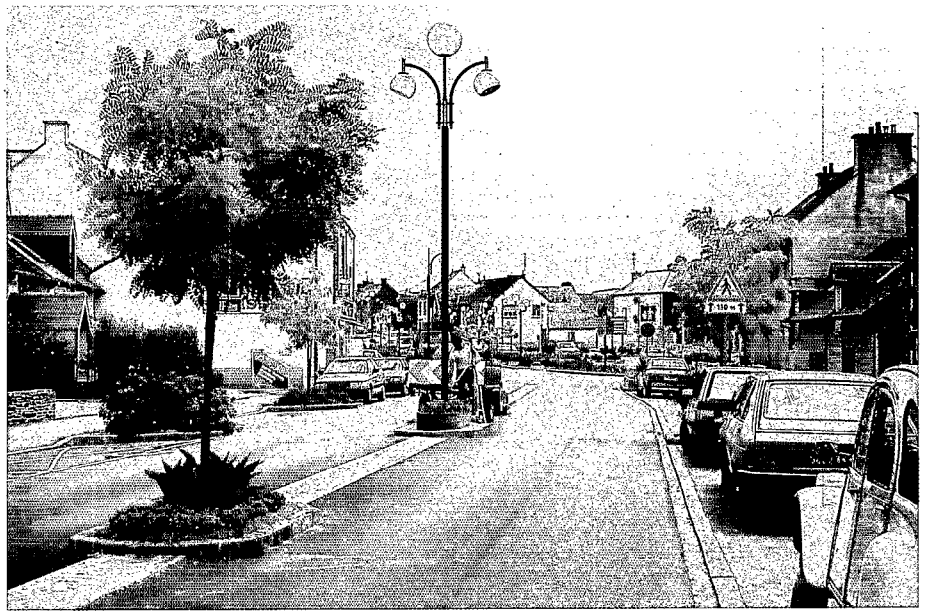
The road has two lanes along the entire stretch. On part of the stretch there is a 60 cm wide central reservation with hard-burned paving bricks and a row of characteristic lamp posts.

The pedestrian crossings are also paved with hard-burned bricks and in some places they are raised. However, no marking of the carriageway has been used.

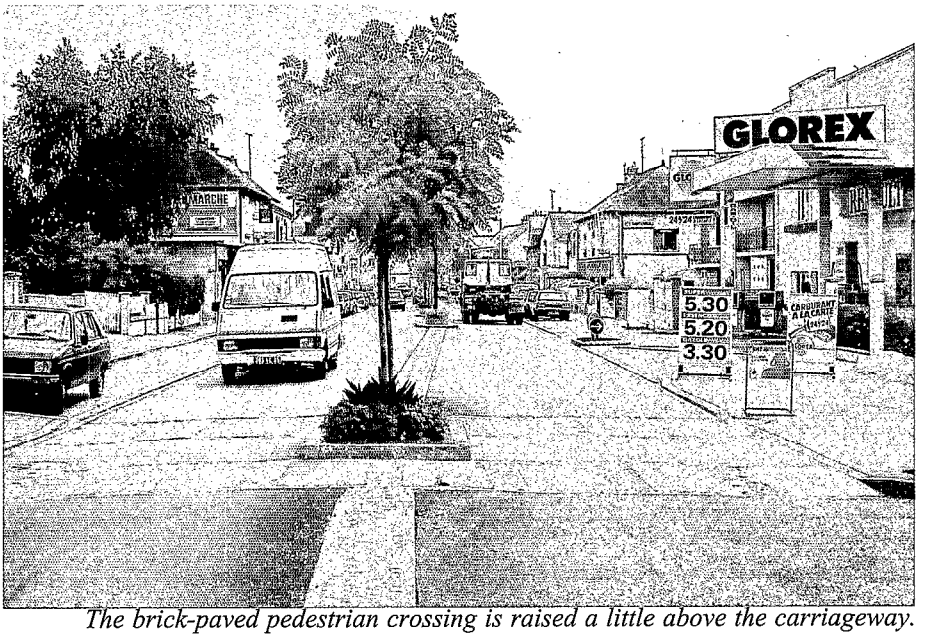
On a section with no central reservation the road surface changes at about 10 m intervals into cobbled squares, each 4 x 4 m. First and foremost these areas indicate entrances to car parks, and secondly they give the visual impression that the street is divided into short stretches. On this part of the road lamps and plantings, i.e. trees and flowers, are placed along the roadside, between the carriageway and the sidewalk.

Road signs have been erected specifying 45 km/h.

The conversion of the road was completed in 1988.



The central reservation is just wide enough for a pedestrian.

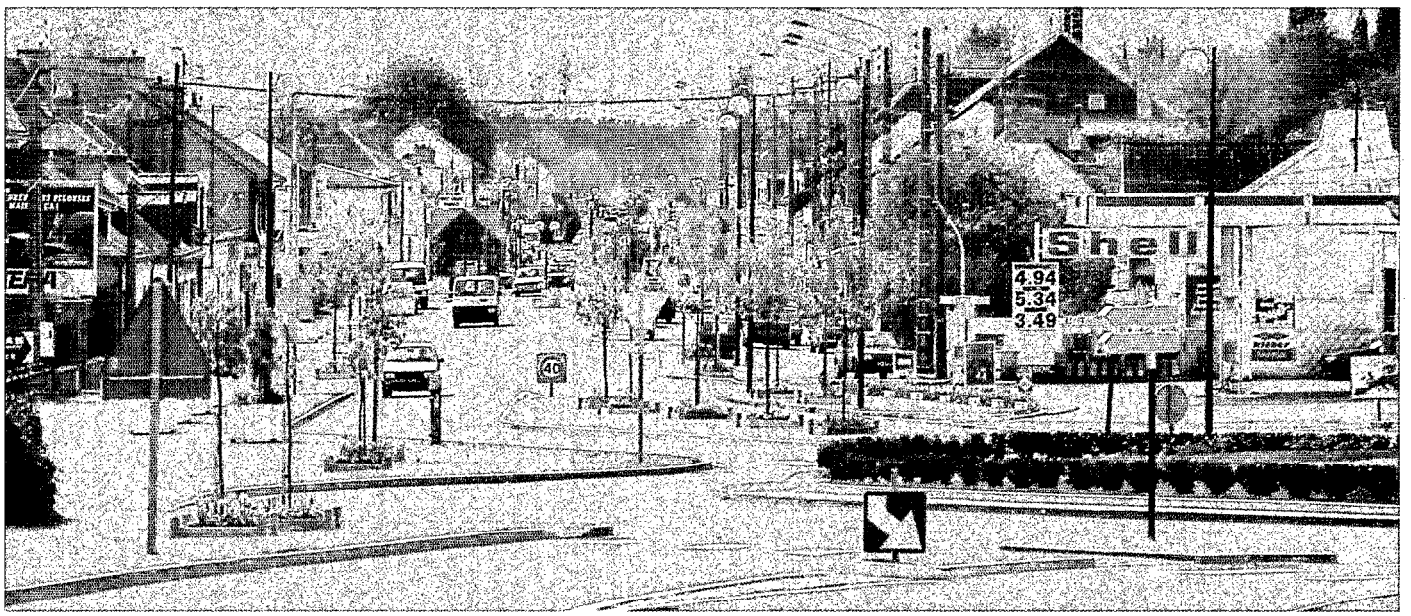


The brick-paved pedestrian crossing is raised a little above the carriageway.

	Before (1987)	After (1991)
Car traffic	6,800 vhl/24 hrs	7,300 vhl/24 hrs
Speed specified by signs	-	45 km/h
Mean speed at point, both directions		(1991)
- western entrance	-	33 km/h
Accidents	(1982-86)	(1988-91)
- involving personal injury	0.2 accidents per year	None

Source: CETUR.

Highway through Arnage, France



In Arnage, a suburb of Le Mans, the heavily trafficked main street has been rebuilt in order to improve both traffic safety and the quality of the urban environment.

The Town

Arnage is a southern suburb of Le Mans, the capital of the Sarthe department, 190 km south-west of Paris.

Arnage itself has 5,500 inhabitants. The town lies squeezed in between the River Sarthe and a railway line, and is also cut through by the Route Nationale 147 running between Le Mans and Angers *(54)*.

The Background

In the beginning of the 1980s the 25 m wide main street, which functions both as a traffic artery and as a shopping street, had an annual traffic per day of no less than 25,000 cars. In 1983 a bypass was built, and the annual traffic per day was reduced to 13,000 cars *(73)*.

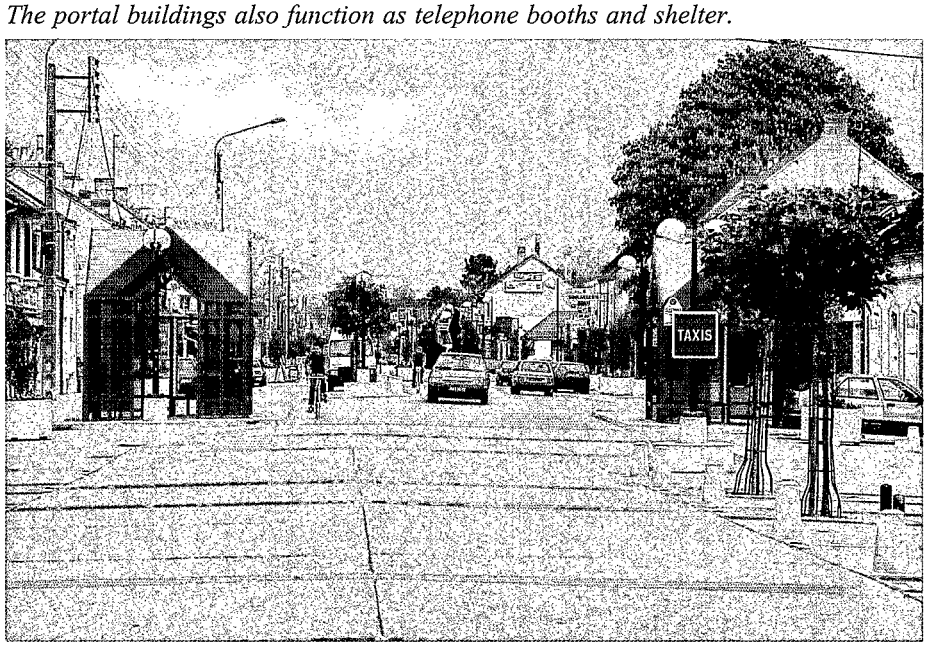
The lower traffic intensity, however, gave rise to higher speeds, and the risk of accidents and the insecurity were still unacceptable.

Planning

It was therefore decided to rebuild the street. Both the decision and the subsequent planning aimed at several objectives. First of all to change driver behaviour. Secondly, to improve the outdoor environment and instil new life to the shopping in town. And thirdly, to generally improve the environmental qualities of the town. Mainly by rebuilding the road itself, but also by encouraging improvements of the buildings.

Project scope	1,200 m highway
Inaugural year	1988
Costs	DKK 10.3 m

The portal buildings also function as telephone booths and shelter.



Design

Until today, only part of the 1,200 m long main street has been rebuilt. The converted stretch, which displays road signs specifying a speed limit of 40 km/h, is marked by a gate at each end. The gate is formed as a roundabout where the part of the carriageway that is closest to the central island is paved with light brown concrete paving stones.

The transition between country and town is also indicated by staggering and narrowing of the carriageway, changed road surface, lower lamp posts, and two portal buildings.

The staggering and the changed road surface mean that the continuous character of the road is effectively broken. The area which has been gained by narrowing down the carriageway to 6 m is used for parking, cycle lane, and pedestrian zone.

The two portal buildings contain telephone boxes and information boards, and also function as shelter for waiting bus passengers.

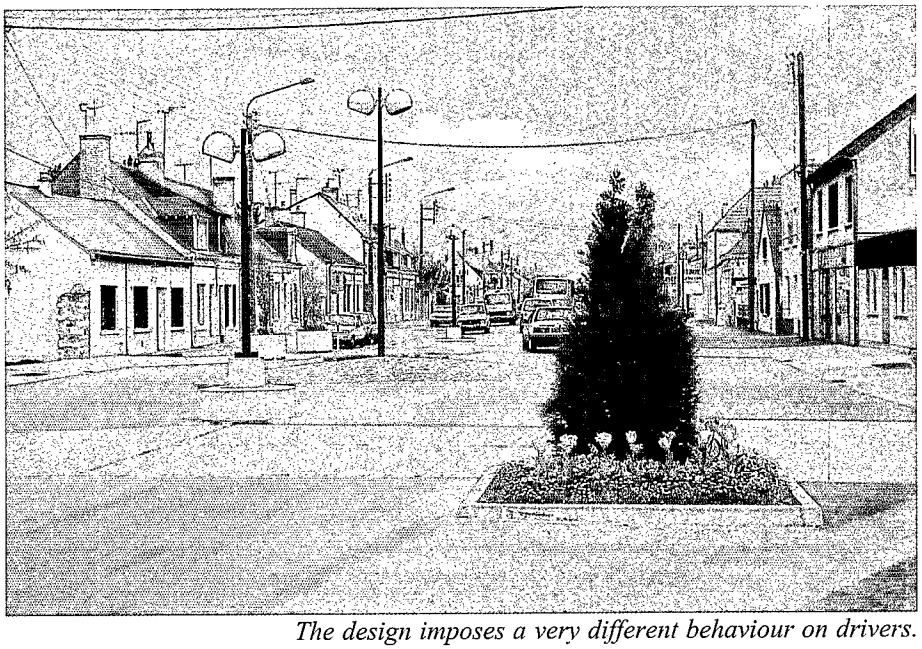
The central intersection in the town is designed as an octagonal square, regulated as a roundabout, and also off-set some metres to one side of the main street axis. In the central island a characteristic sculpture has been erected.

Among all traffic calming schemes implemented until today, the redesign of the main street in Arnage represents one of the most pronounced changes of the visual environment.

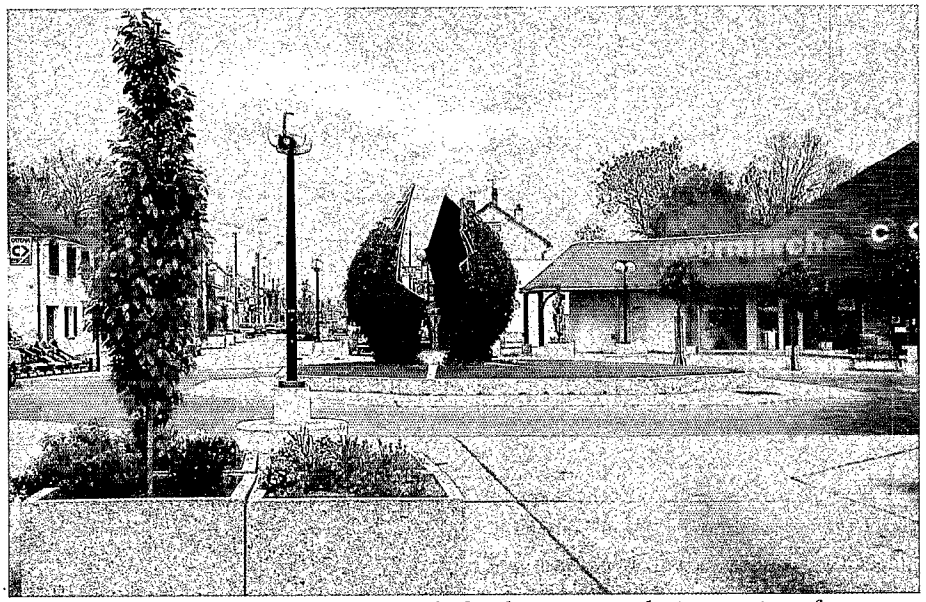
Results

The conversion has stimulated trade and pedestrian traffic in the shopping street. In addition it has inspired houseowners and shopowners to improve the visual appearance of their houses.

Both car speeds and the number of accidents have been reduced *(71)*.



The design imposes a very different behaviour on drivers.

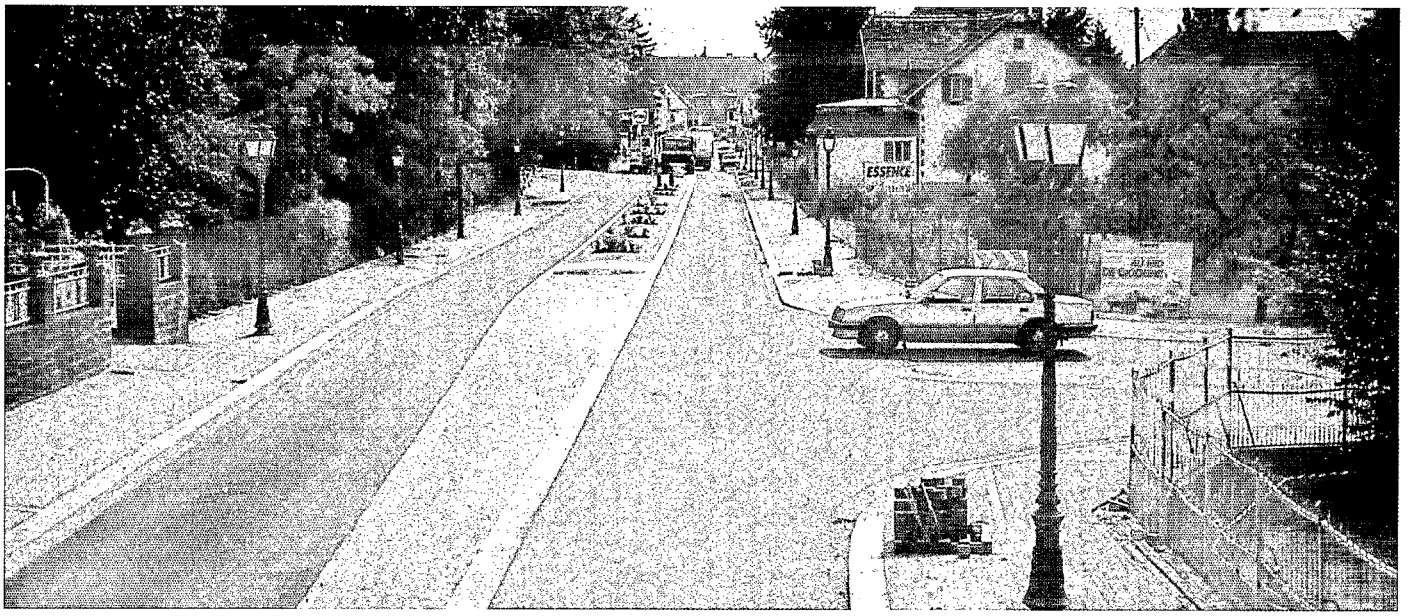


The sculpture and the form of the central island accentuate the impression of a square.

	Before (1985)	After (1991)
Car traffic	13,000 vhl/24 hrs	17,000 vhl/24 hrs
Speed specified by signs	-	40 km/h
Mean speed/share > 50 km/h at point, both directions		
- Towards Angers	-	42 km/h/15%
- Towards Le Mans	-	35 km/h/8%
Accidents	(1982-86)	(1988-90)
- total	3.0 accidents per year	1.3 accidents per year
- involving personal injury	-	1.3 accidents per year

Source: CETUR.

Highway through Mutzig, France



Mutzig is one of the many beautiful towns in Alsace, and the conversion that was made of the main street in the 1980s lives up completely to the inherent charm of the town.

The Town

Mutzig stands on the Route National 420 about 25 km to the west of Strasbourg, i.e. in the Bas-Rhin department in Alsace. The town has long been a trading centre in the area and in the summer and during the vintage many tourists visit or drive through the town.

Mutzig has 4,100 inhabitants.

Project scope	
- 1st stage	650 m highway
- 2nd stage	1,000 m highway
Inaugural year	
- 1st stage	1985
- 2nd stage	1989/90
Costs	
- 1st stage	DKK 4.8 m
- 2nd stage	DKK 6.2 m

The Background

As in the area around Rennes also many towns in Alsace are interested in the possibility of traffic calming as expressed in the "Ville plus sûre - Quartiers sans accidents" programme.

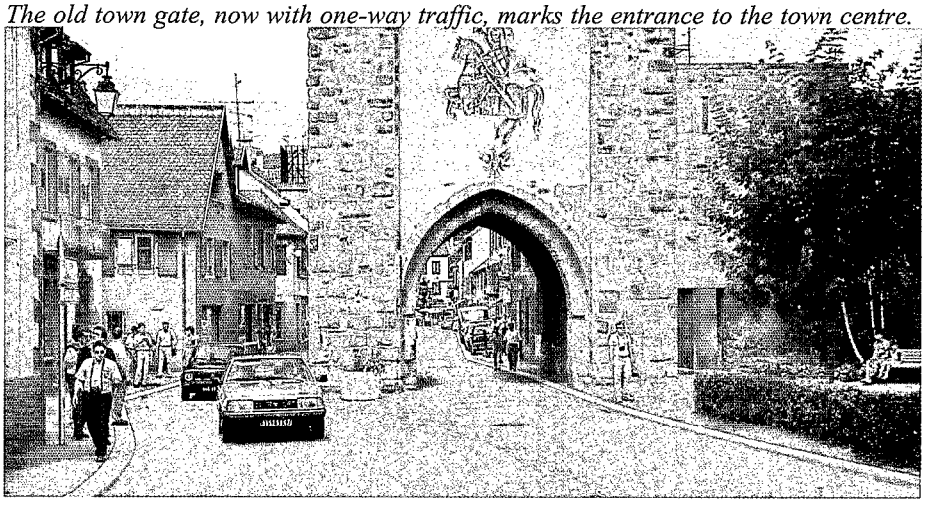
The main street in Mutzig, R.N. 420, has an annual traffic per day of 8,000 cars. The municipality wanted to make this traffic quieter, and at the same time reorganize the somewhat chaotic parking habits along the street and, especially, on the central square.

Planning

Like the other French towns mentioned in this catalogue of examples, Mutzig saw the opportunities of the "Ville plus sûre"-programme as regards both the technical expertise attached to the programme and the state funding available.

On the usual conditions of the programme the planning stage was carried through with the following objectives:

The old town gate, now with one-way traffic, marks the entrance to the town centre.



- to lower car speeds
- to case conditions for pedestrians, especially their possibilities of crossing the road
- to indicate clearly the different uses of the outdoor areas and, especially, reorganize parking in town
- to accentuate the historical qualities of the town
- to stimulate local trade

This led to a detail design for the main street, implemented in two stages. The first 650 m in 1985 and the last 1,000 m in 1989/90.

Design

The main street design is characteristic mainly because of the very marked visual interruptions of the alignment, an effect achieved by using light granite flags which separate the carriageways from pedestrian areas and from parking bays. The granite flags used were specially made for this scheme.

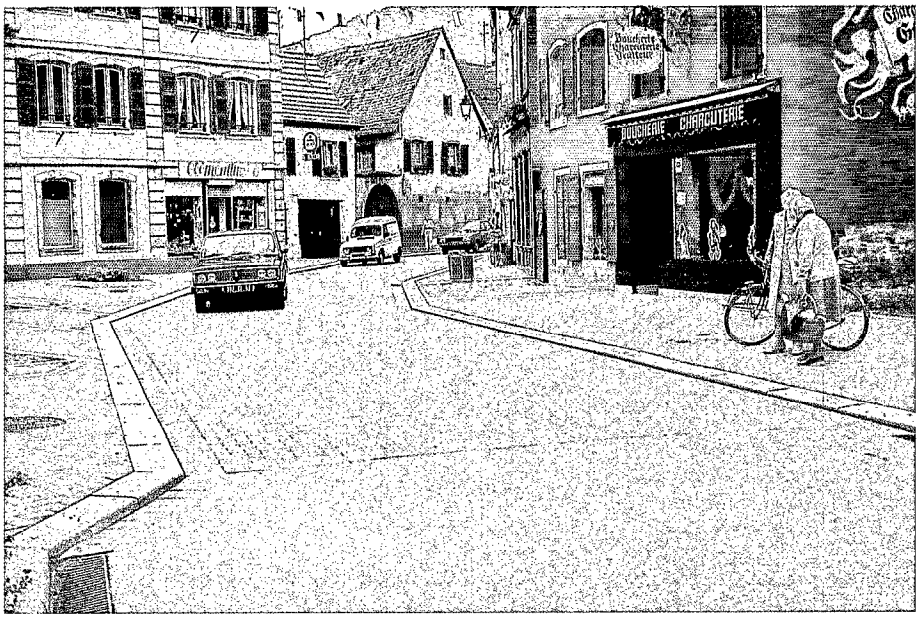
The whole conversion is characterized by the use of many materials in a variety of colours: concrete paving stones of different sizes, cobbles and asphalt in black, brown, red, grey, and white colours. To the Danish observer the abundance of materials, shapes, and colours can be almost overwhelming at first, yet it all looks attractive and in keeping with the town scene generally *(55)*.

In addition, an entire range of street equipment has been designed for the scheme.

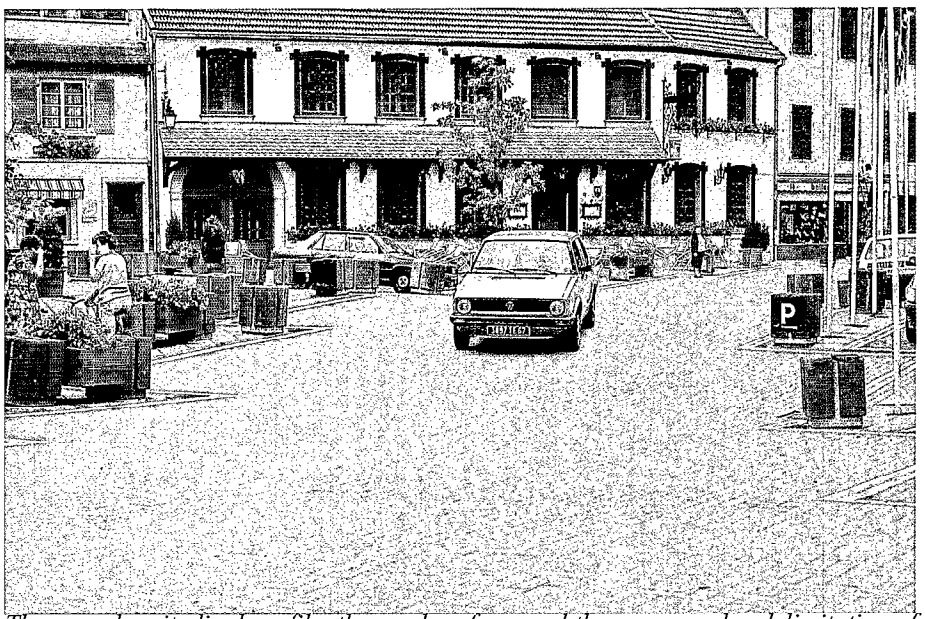
Results

The conversion of R.N. 420 through Mutzig has caused a marked reduction of car speeds and a welcome pacification of the town. Pedestrians now use the streets and especially the central square much more, and the inhabitants have felt inspired to embellish the house fronts and front areas.

And very importantly: the frequency of accidents has been lowered significantly.



The carriageway is only between 4.8 and 6 m wide, but the very low granite flags encourage the drivers to use the entire width.



The wavy longitudinal profile, the road surface, and the very angular delimitation of the carriageway is a clear signal to the drivers that they should drive slowly.

	Before	After
Car traffic		(1987)
- 1st stage	8.000 vhl/24 hrs	8.000 vhl/24 hrs
Speed specified by signs	-	30 km/h
Mean speed at point, both directions		
- 1st stage	50 km/h	25 km/h
Accidents 1st stage	(1978-82)	(1986-90)
- total	2.2 accidents per year	0.2 accidents per year
Accidents 2nd stage	(1985-89)	
- total	2.4 accidents per year	-

Source: CETUR.

Town Centre in Buxtehude, Germany

During the 1980s a large full-scale study has been conducted in Buxtehude, including extensive rebuilding in the town centre and in an adjoining urban area, and in-depth initial and follow-up studies of the traffic and the environment. The principles developed in this connection became one of the models for the "Tempo 30" programme now in force in German towns.

The Town

Buxtehude is situated in north-east Niedersachsen, 34 km south-west of Hamburg. The town has about 28,000 inhabitants, and the local economy is based on trade and professional services.

The test area includes the northern part of the central town area, covering approximately 220 hectares with almost 11,000 inhabitants *(56)*.

The Background

The area in question was characterized by a heavy traffic load and at the same time by a substantial fence effect due to the railway line running through the town. In a number of residential streets the carriageways were very wide, which resulted in speeding, and the pedestrian and cycle connections, especially east-west through the town, were insufficient and not adequately safe.

Project scope	Major conversion work in town centre
Inaugural year	1987
Costs	DKK 48 m

Planning

It was specially emphasized

- to integrate traffic, urban, and environmental planning
- to include the main traffic arteries in the total traffic calming plan
- to achieve traffic calming in designated areas at a low budget
- to pay special attention to pedestrian and cycle traffic

It was decided to implement the changes in two stages.

Bahnhofstrasse has been converted to a "shopping boulevard".

Design

During the first and temporary phase the following techniques, among others, were utilized:

- division of the total area into 2 Tempo-30 areas with signs placed at the entrances
- introduction of normal right-hand right of way in the intersections in the two areas
- narrowings of the carriageways at the entrances to the Tempo 30 areas.

The changes made during phase one, which was completed in 1983, cost a total of DEM 160,000.

Most of the changes proved to function as intended and therefore the second stage was in effect a consolidation of the individual speed reducers into permanent constructions made according to the same principles. This stage included, for example

- renewal and part-conversion of distributor roads
- conversion of the entrances to the Tempo 30 areas
- conversion of streets into cycle streets
- spot-wise measures such as cobbled surfaces at crossing points and narrowings
- conversion of a large street into a "shopping boulevard"
- conversion of the streets into pedestrian streets in the most ancient parts of town

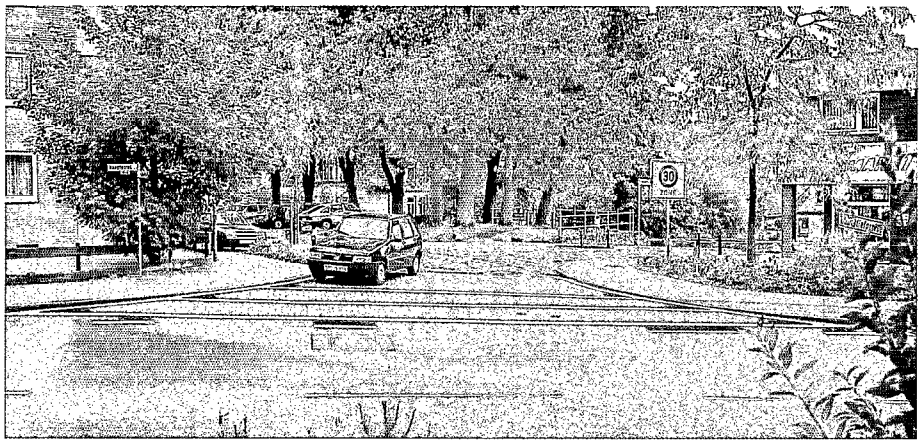
These changes, which were completed in 1987, cost a total of DEM 12 m.

Results

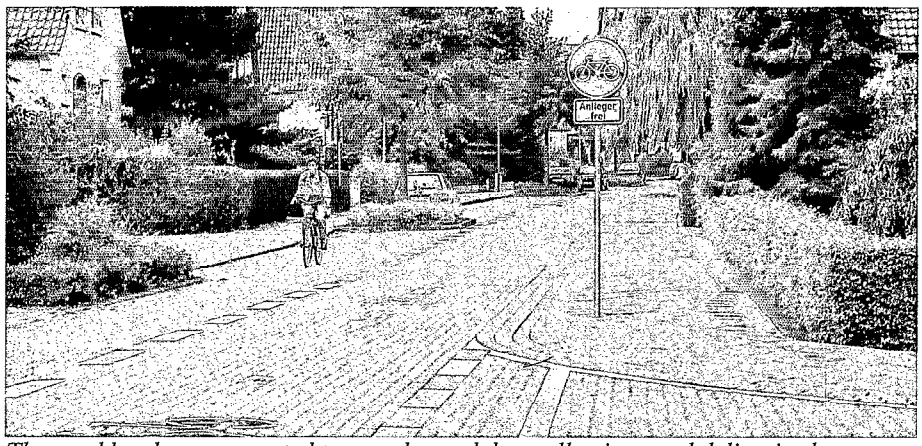
The changes have caused a considerable increase in pedestrian and cycle traffic in the area, i.e. 17% and 27% respectively. Over the same period the car traffic has increased by only 2%.

Average car speeds in the residential streets have fallen from 35 km/h to 32 km/h and in the distributor streets from 45 km/h to 34 km/h. On the surrounding traffic roads (where there is no 30 km/h speed limit) speeds have fallen from 54 km/h to 51 km/h.

In the Tempo 30 areas the number of accidents involving personal injury has dropped by 60%, and the accident costs by 42%. Conversely, on the surrounding roads there have been increases of 24% and 20% respectively, which to a great extent, however, is due to extensions of these roads and the resulting substantial increase in traffic.



The entrance to the Tempo 30 area is marked with signs and with concrete paving stones.



The road has been converted to a cycle road, but collections and deliveries by car are permitted.

	Before	After
Speed specified by signs		
- Distributor roads	-	30 km/h
- Residential roads	-	30 km/h
- Surrounding traffic roads	-	50 km/h
Mean speed/85% quantile at point, both directions	(1983)	(1988)
- Distributor roads	45/53 km/h	34/40 km/h
- Residential roads	35/44 km/h	32/35 km/h
- Surrounding traffic roads	54/64 km/h	51/60 km/h
Accidents	(1981-83)	(1985-87)
- total	195.7 accidents per year	209.7 accidents per year
- involving personal injury	31.3 accidents per year	26.3 accidents per year

Source: (56).

Through Roads in Nordrhein-Westfalen, Germany

In Germany, especially in the land of Nordrhein-Westfalen, one is equally far as in Denmark regarding environmentally adapted conversions of through roads.

The Background

In 1984 the minister of town planning, traffic, and transport in the German land of Nordrhein-Westfalen launched a large-scale experiment aimed to achieve a general speed reduction on roads through small towns.

No less than 28 towns, all rather small and with moderate through traffic, were chosen to participate in the experiment *(57, 58, 59)*.

Planning

The main criterion for selecting the towns was the number and gravity of traffic accidents in 1982. Some other criteria utilized were that: the length of the through road should be limited (300-1,000 m); traffic intensity should be between 2,000 and 8,000 vehicles per day; and the alignment of the roads should be of the type that tempts to speeding.

A working party appointed by the minister prepared common guidelines for the methods and geometrical design to be utilized and for the studies that had to be started.

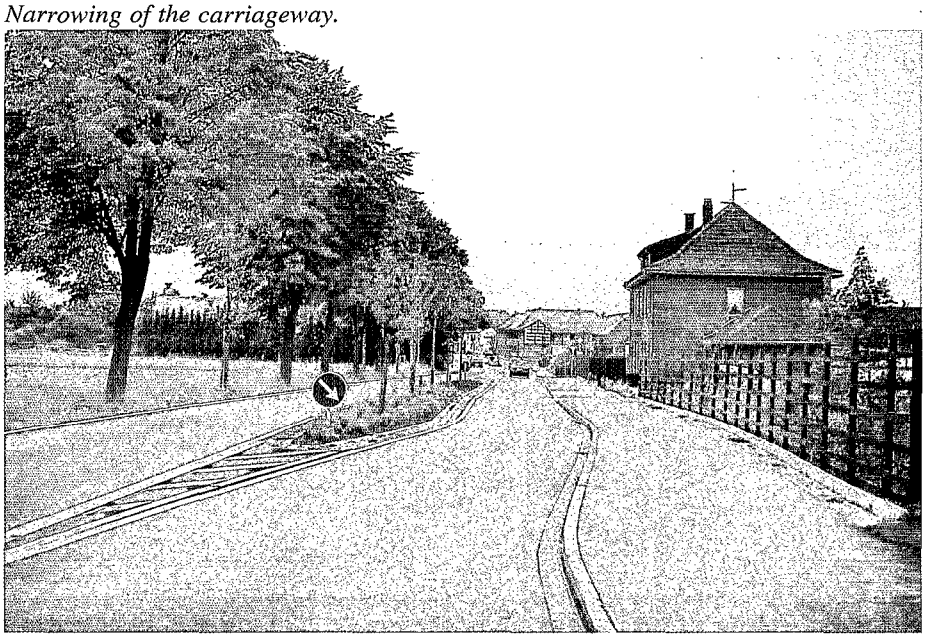
Two consultancy groups were asked to make studies of 14 towns each, namely the Institute of Road transport and Town Planning, and a group formed by the German insurance companies.

Design

The catalogue of techniques which was prepared initially was inspired partly by the "Highways through Towns", a catalogue of ideas issued by the Danish Road Directorate in 1981 (9), and included

- narrowing of the carriageway through the whole town

Narrowing of the carriageway.



- short narrowings of the carriageway
- central traffic islands
- conversion of intersections, e.g. into roundabouts
- changed road surfaces, materials and colours
- other design-based techniques
- road signs and traffic lights

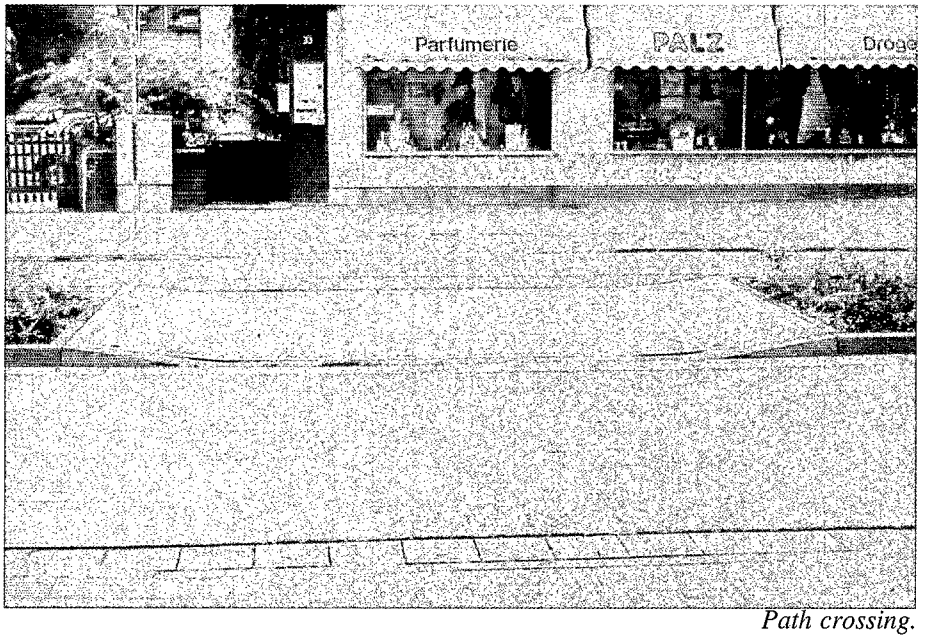
One of the experiences from the pilot project was that in certain cases the attempt to apply the common guidelines to towns with different characteristics led to inappropriate solutions and to poor co-ordination with other planning in these towns.

Traffic island.

Results

The effects of the conversions were monitored through before- and after-studies of speed, traffic accidents, traffic intensity, parking, driver behaviour, and drivers' and town inhabitants' attitudes.

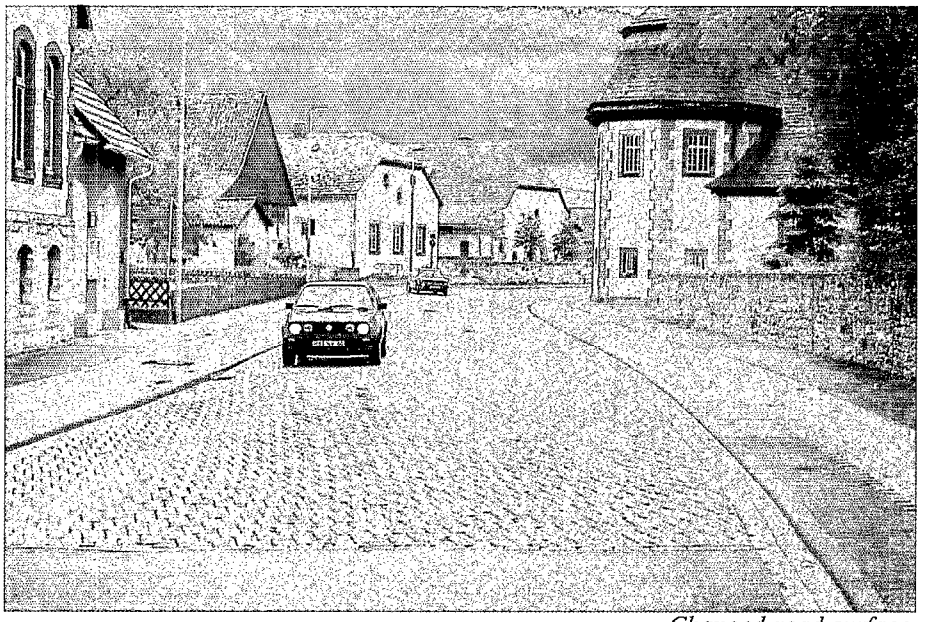
As regards speed the studies revealed that road signs and marking of the carriageway only had little effect. Any significant speed reduction requires physical measures such as staggerings combined with traffic islands, roundabouts, or change of the road surface to rougher materials, preferably combined with a slightly raised carriageway level.



Path crossing.

Only few accidents occurred on the roads before the conversion and, on balance, slightly fewer after. Due to the very limited statistical data it has not been feasible to demonstrate a positive connection between the various measures and the accident rate.

In spite of the rather meagre statistical results of the many experiments a wide range of practical experience has been gained, which has already had a strong influence on the German design standards for traffic roads in towns.



Changed road surface.

Through Road in Buldern, Nordrhein-Westfalen

In Buldern a series of design principles have been applied which are similar to Danish practice. However, lane widths are larger, and the red cycle ribbon-lanes so typical of German towns run through the town.

The Road

The road through Buldern is curved and the street space is wide. There is a fair amount of cycle and pedestrian traffic on the road, and the roadside development is a mix of housing and shops.

Design

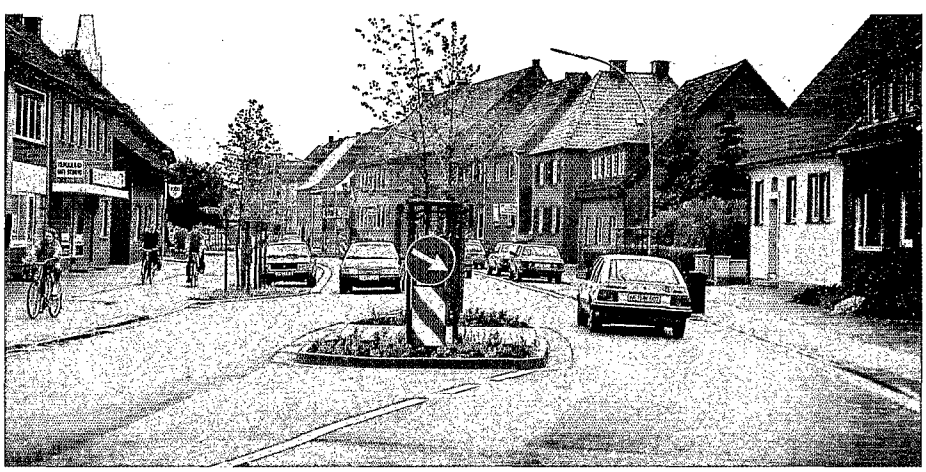
At the entrance to the town a central traffic island with plantings has been placed, and through the town there are a number of staggerings, traffic islands, and roadside reservations.

Through the staggerings the carriageway is 4.0 m wide to allow room for special vehicles. However, the outer 30 cm on both sides are paved with white paving stones so that visually the carriageway appears to be only 3.4 m wide.

Due to the risk of collisions the kerbstones in the right-hand side of the staggerings are only 6 cm high, whereas on the left-hand side, on the traffic islands, they are 12 cm.

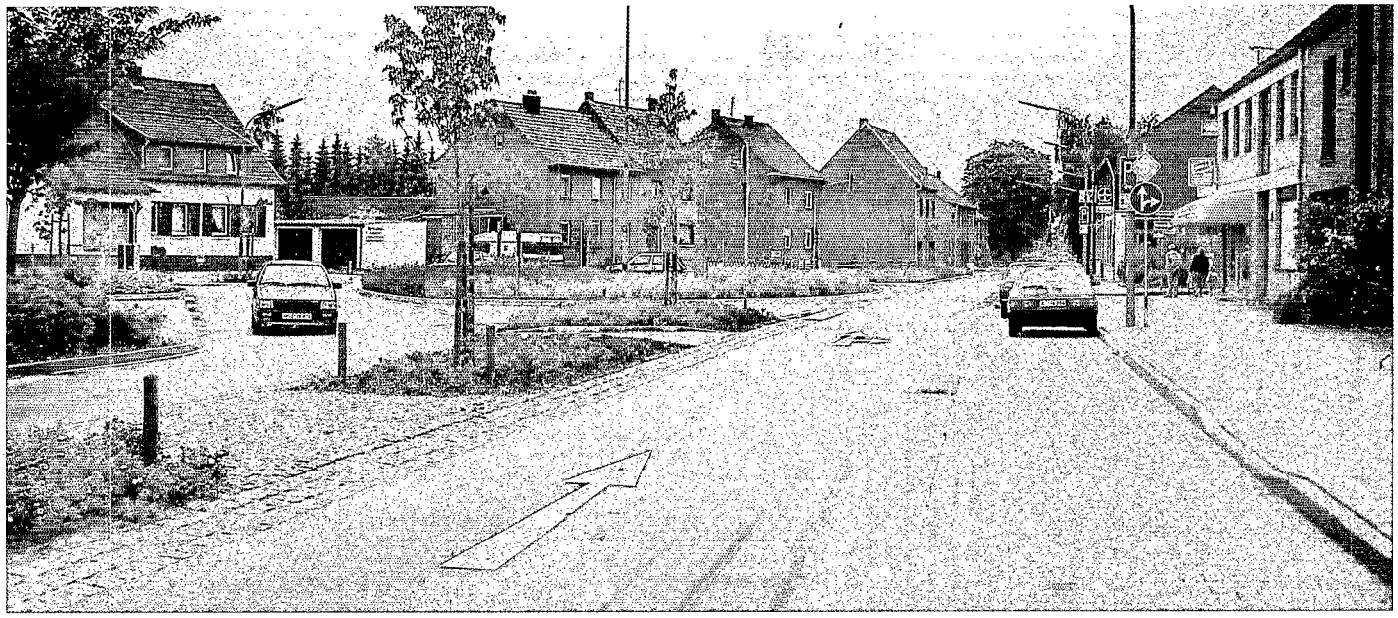
At the entrance to the town a cycle track starts in the form of a shared track. Further on into the town it changes to a divided track with a 1.2 m wide cycle area paved with red, hard-burned bricks. The cycle track is delimited towards the carriageway by a 40-60 cm wide reservation paved with dark blue concrete paving stones.

The traffic islands and the roadside reservations are planted with trees and with a ground cover of roses and horn-beam. In between the roadside reservations 2.25 m wide parking lanes have been provided - apart from one section where angle parking has been used *(58, 60)*.



The road through Buldern is very similar to a Danish environmentally adapted through road.

Through Road in Gerderath, Nordrhein-Westfalen



In Gerderath two of the intersections have been rebuilt - resulting in positive visual and speed reducing effects. One intersection now has a raised area, the other has been converted to an asymmetrical roundabout.

The Road

Gerderath is a fairly small village, centred around the through highway. The road alignment is curved and there are two large intersections in the town.

Design

The conversion consists of gates at the entrances, fairly long traffic islands, raised area in one intersection, and a roundabout in another.

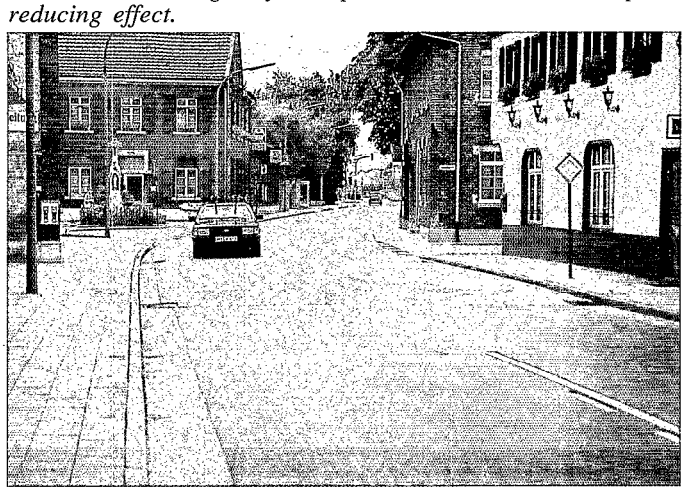
The gates are designed as a slight staggering to the right, flanked by trees. The staggering is created by means of a traffic island with trees and a marked ground cover, edged by cobbles.

Further on into the town there are similar islands, although without the staggering. All islands are edged by three courses of cobbles at a gradient of 20%.

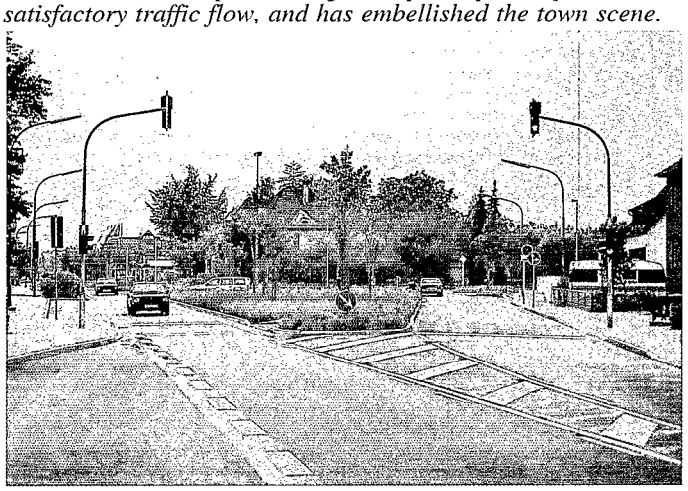
A staggered intersection in the middle of the village has been provided with a raised carriageway with red concrete paving stones and with black and yellow stones on the ramps. The area has been raised 10 cm and the ramps are 3 m long, which according to Danish regulations would correspond to a design speed of about 55 km/h. To make the right-of-way conditions for pedestrians very clear, the sidewalks are raised another 10 cm above the raised carriageway.

In the other big, and rather irregular intersection in the town the former traffic lights caused a limited capacity and turning was complicated. Instead, an oblong, roundabout-like intersection was constructed, with a pear-shaped, beautifullyplanted central island.

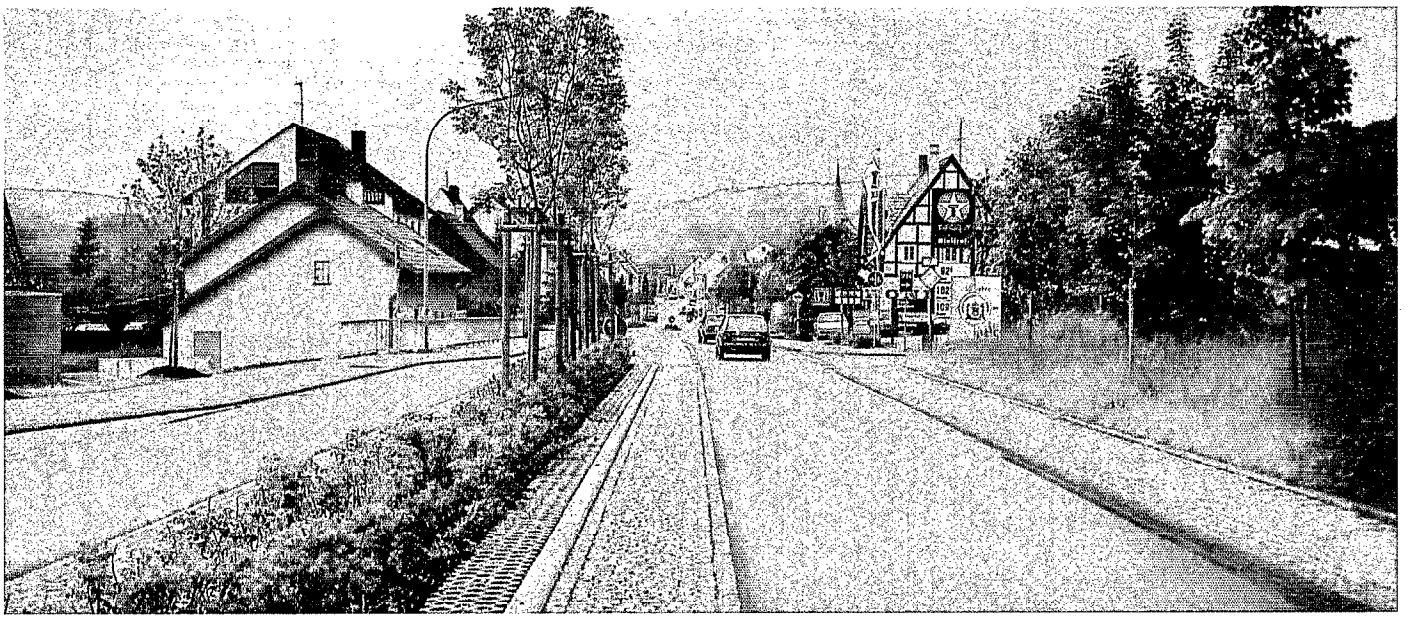
The raised carriageway has produced the intended, speed reducing effect.



The roundabout-inspired design dampens speeds, produces a satisfactory traffic flow, and has embellished the town scene.



Through Road in Westheim, Nordrhein-Westfalen



In Westheim the many wide-body, armoured vehicles necessitated a special design of the speed reducing devices. The answer was a division of the carriageway into asphalted and cobbled areas.

The Road

Every day approximately 7,000 vehicles drive on the straight highway through the town of Westheim. Part of the through traffic are heavy and wide-body armoured vehicles.

Design

The conversion of the highway through the town included gates, traffic islands, double staggerings in intersections, and cycle tracks.

The gates are constituted by a traffic island with plantings and trees planted along the road.

Similar islands have been provided through the town. To accommodate the wide-body vehicles, which need a 4 m wide lane past the islands, the lane has been divided into a 3 m wide asphalt area and a 1 m wide cobbled area nearest the island. The cobbles are so bumpy that ordinary drivers would rather avoid them and so only use the asphalted area. The island is edged by a 6 cm high white concrete kerb.

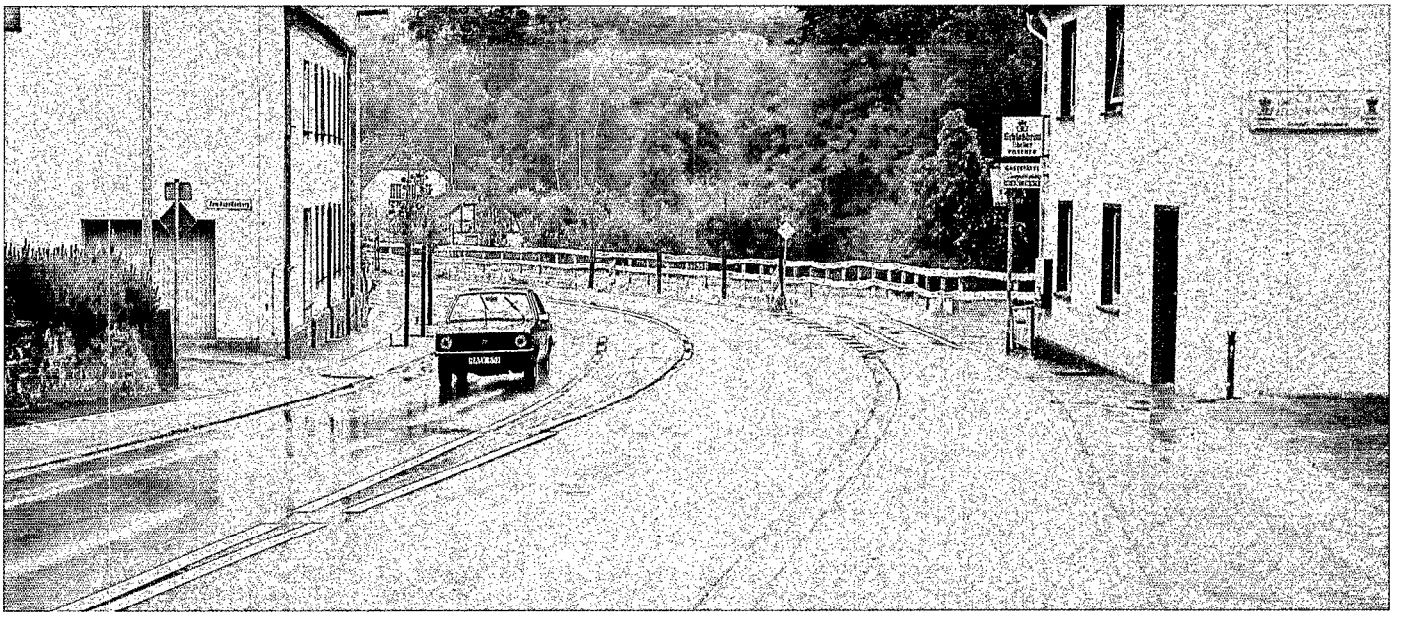
In the intersections, double staggerings have been established by means of traffic islands, which has left space for left-turn lanes in the middle of the carriageway. Here as well the drivers only utilize the asphalted area, even though it requires extra turning of the steering wheel.

The cycle tracks through the town have been made as part of a divided track, 1.5 m wide and paved with red hard-burned brick. The track is separated from the carriageway by a 6 cm high, dark concrete kerb *(58, 60)*.

Project scope	750 m highway
Inaugural year	1987
Costs	DKK 9.8 m

Also through the staggered intersection the cars use only the asphalted area.

Through Road in Rheder, Nordrhein-Westfalen



In Rheder the through road separates a castle from its adjoining buildings. After the conversion the road appears as a kind of castle yard.

The Road

The highway through the little Westphalian village of Rheder is curved, but rather wide. On a section approximately 100 m long the road carves through an old castle, so that it separates the main building from its dependent buildings.

Design

The conversion of the road through Rheder has included gates at the town entrances, narrowing of the carriageway, provision of cycle tracks on both sides of the road, the establishment of a single traffic island, and particularly a special treatment of the stretch through the castle area.

The gates at the town entrances are made by a row of trees on both sides of the road, placed between the new cycle track and the carriageway.

The carriageway has been narrowed down to 6.5m through the town, but only the 6 m are actually asphalted since 15 cm wide light-coloured paving stones have been laid along the outer edges.

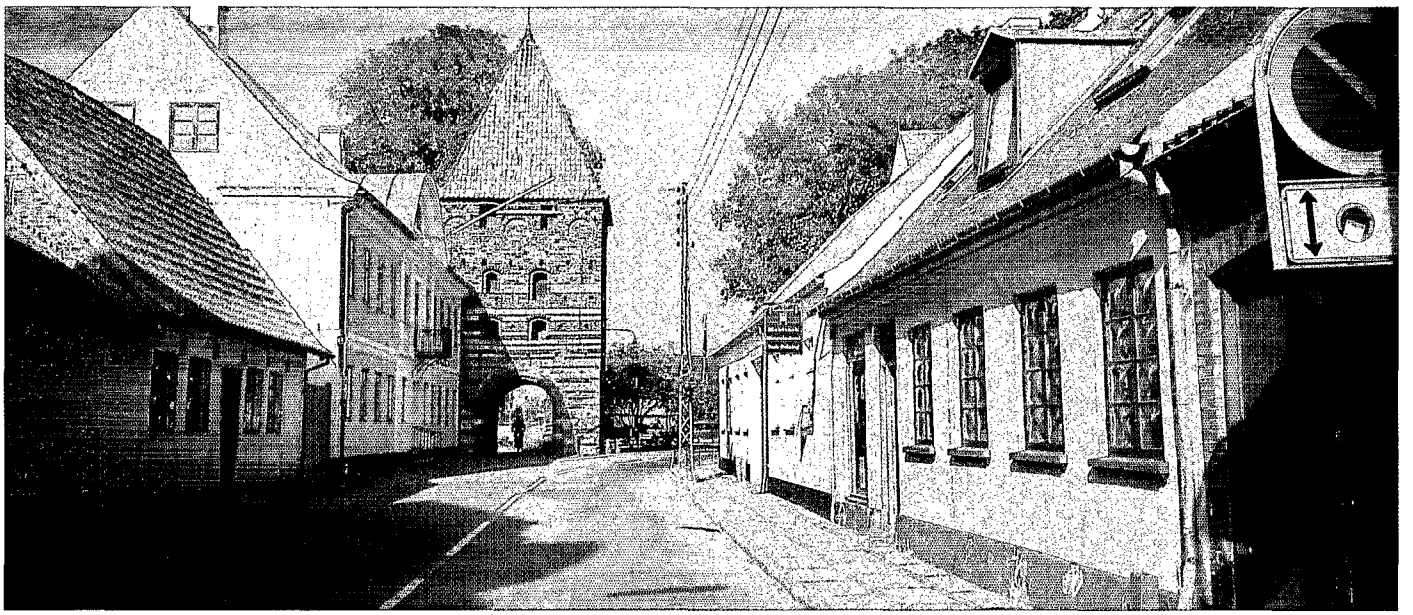
Project scope	Gates, cycle tracks, central island, and narrowing of carriageway
Inaugural year	1986
Costs	DKK 4.1 m

The cycle tracks are designed as part of a divided track, 1 m wide and paved with red hard-burned bricks. The sidewalk is almost 1 m wide, paved with dark grey concrete flag stones, and separated from the cycle track by a 10 cm wide line of paving stones.

On the approximately 100 m long stretch through the castle area a stone pavement has been chosen which gives the area the air of a castle yard. The result illustrates well that road building can create beautiful town spaces *(58)*.

The stone pavement through the castle area makes the space cohere, and signals to the drivers that they should be cautious.

Gates - a Theme



In recent years gates have been established at a large number of Danish towns - as part of the conversion of roads, or as the only device there. The inspiration comes from the ancient town gates, and the purpose is to tell the drivers that they are approaching a town and that they have to reduce speed. The gate effect can be created in many ways.

Haderup

In 1988-90 the Danish Road Directorate had gates erected at 7 towns. One of them was Haderup, which is situated about midway between Herning and Skive, in Ringkjøbing county and Avlum-Haderup municipality. In 1988 two gates were erected at Haderup, in connection with the conversion of the central square of the town.

A town gate consists of two 6 m tall timber-built towers finished by a steel lattice on top. The towers are illuminated from the inside so that they are also very visible at night. Additionally, there is a white marking across the carriageway between the towers.

The price for each of the gates was DKK 42,000, exclusive of lighting and road signs.

In 1989 speed measurements and questionnaire interviews were carried out in Haderup and Feldballe, among others.

In Haderup both gates proved to have reduced speeds, but to different degrees. At the southern gate the average speed had been reduced by 8 and 4 km/h for traffic to and from the town respectively. At the northern gate car speeds were 3 km/h slower towards the town, whereas speeds out of the town were unchanged.

The questionnaire study showed that 71% of the inhabitants liked the idea of the town gates and that no less than 83% found the gates pretty. The majority, however, still thought that the drivers drove too fast, and only 4% believed that the gates had reduced speeds *(61)*.

Haderup.

Feldballe

Feldballe is situated in Rønde municipality in Århus county, 10 km to the north-east of Ebeltoft. In 1987/88 a gate was built at the southern border of Feldballe in connection with an extension of the path system through the town.

The gate consists of 3 m tall wall sections, supplemented with changed road surface, special lamp posts and funnel-shaped plantings, i.e. closest to the carriageway nearest the town.

The establishment of the gate caused a 3 km/h reduction of average speeds in the gate area, and a 4 km/h reduction 150 m within the gate.

In Feldballe 57% found that the town gates were a good idea, but only 36% thought that the gates chosen were pretty. The majority found that the cars were still driving too fast, and only 10% believed that the gates had reduced car speeds *(71)*.

Feldballe.

Skærbæk

In recent years the county of Southern Jutland has established both permanent and temporary town gates in a number of towns.

Skærbæk, with 4,000 inhabitants, is located at the railway and around the highway between Tønder and Ribe. In conjunction with the conversion of the highway to an environmentally adapted through road, town gates were established at the northern and southern borders of the town.

The gate is made by two rows of trees planted as a short, funnel-shaped avenue, and by a narrowing of the carriageway. The cycle path, the sidewalk, and the kerb through town start at the gate area.

The conversion of the road through Skærbæk has reduced average car speeds at the town borders inside the gates by 10 km/h *(12)*. It is impossible to assess how much the gates contribute to the total reduction.

However, a number of speed measurements in connection with the many gates in the county of Southern Jutland have demonstrated

- that town gates must be distinctive to be effective
- that lamp posts alone do not constitute distinctive gates
- that trees and changed road surfaces have no effect alone
- but that a "plug in the hole", i.e. a traffic island, a hump, or similar, reduces speeds

These experiences will be used as a basis for the county road authorities' continued work with town gates.

Skærbæk.

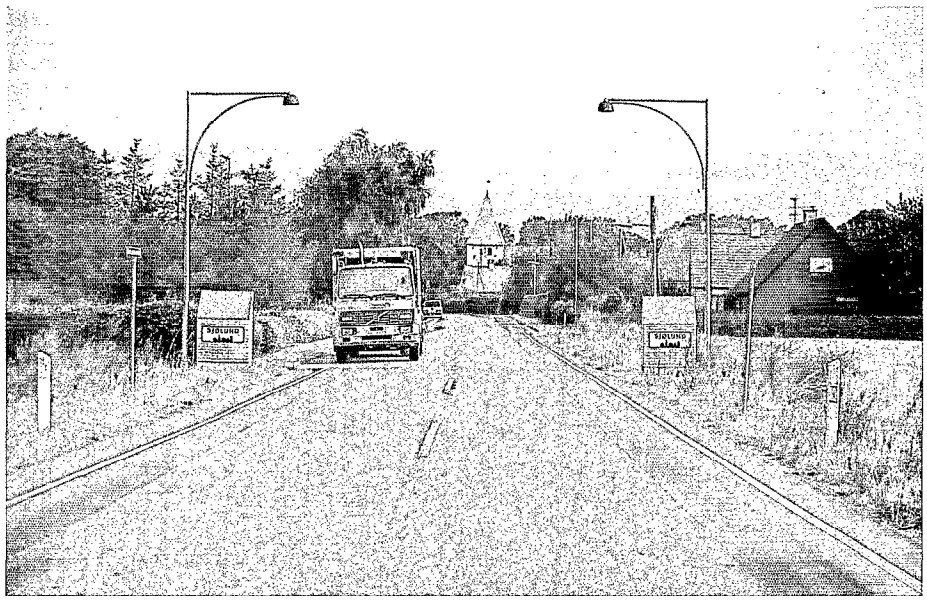
Sjølund

Sjølund is situated slightly more than 5 km to the north-east of Christiansfeld, in Christiansfeld municipality in the county of Southern Jutland. In 1988 two gates were placed at the town.

The gate consists of column-like brick structures, with a sloping top inspired by the village church. In addition, projecting lamps have been erected, and at the southern gate a trunk hedgerow.

The cross-section of the road was left unchanged in conjunction with the establishment of the gates, and car speeds remain almost unaffected.

The price of one gate was about DKK 18,000.

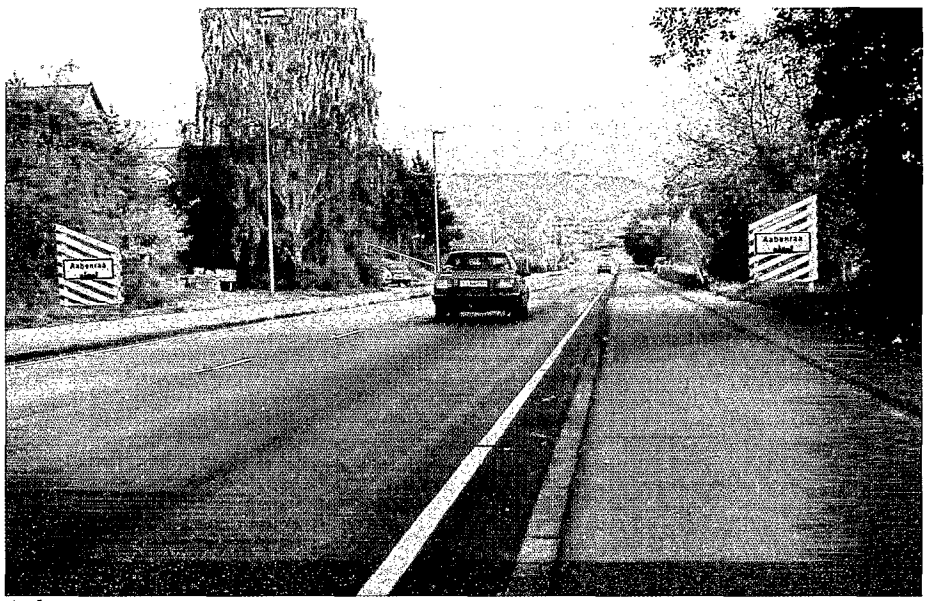


Sjølund.

Aabenraa

No less than 75 similar, and temporary, town gates have been erected on highways in the county of Southern Jutland in connection with the urban-zone sign to make the sign stand out more clearly and to remind drivers that the speed limit must be complied with. In 1991 such a gate was erected at the north-western entrance to Aabenraa on the highway between Rødekro and Aabenraa.

The gate consists of a whitewashed timber structure on each side of the road, 150 cm wide and 160/225 cm tall. The road itself has not been changed.



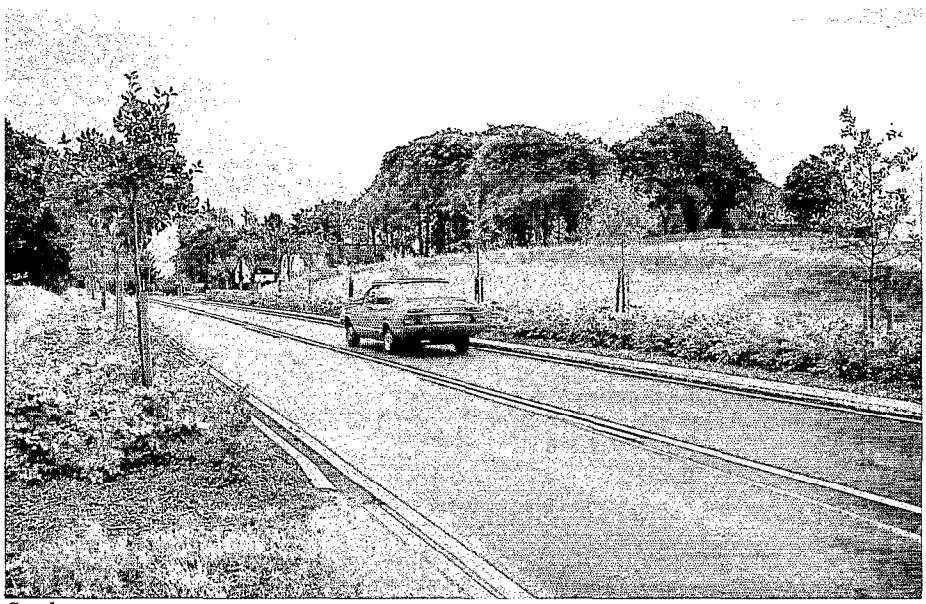
Aabenraa.

Særløse

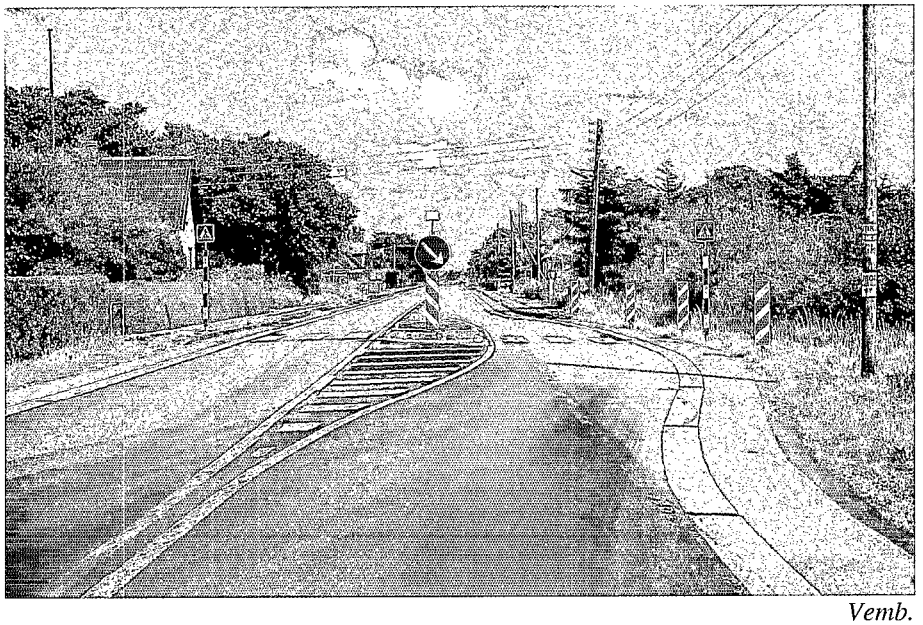
In 1989 two gates were established at Særløse in Roskilde county between Kirke Hvalsø and Osted.

On this road section, which otherwise has no kerbs, the carriageway has been narrowed down by means of kerbs and marking of the carriageway. A perpendicular, visual marking of the gates has been provided by hedges and trees. The gates are not illuminated.

Construction costs were DKK 30-35,000 for each gate.



Særløse.



Vemb.

Vemb

The two gates at Vemb, which lies to the west of Holstebro in Ringkjøbing county, were established in 1990, on a road with an annual traffic per day of 2,600 vehicles.

Each gate has been created by means of a traffic island at a point where a dual track crosses the road. This island makes a staggering of the lane towards Vemb.

According to the county's measurements the gates have resulted in a reduction of average speeds from 66 to 50 km/h.

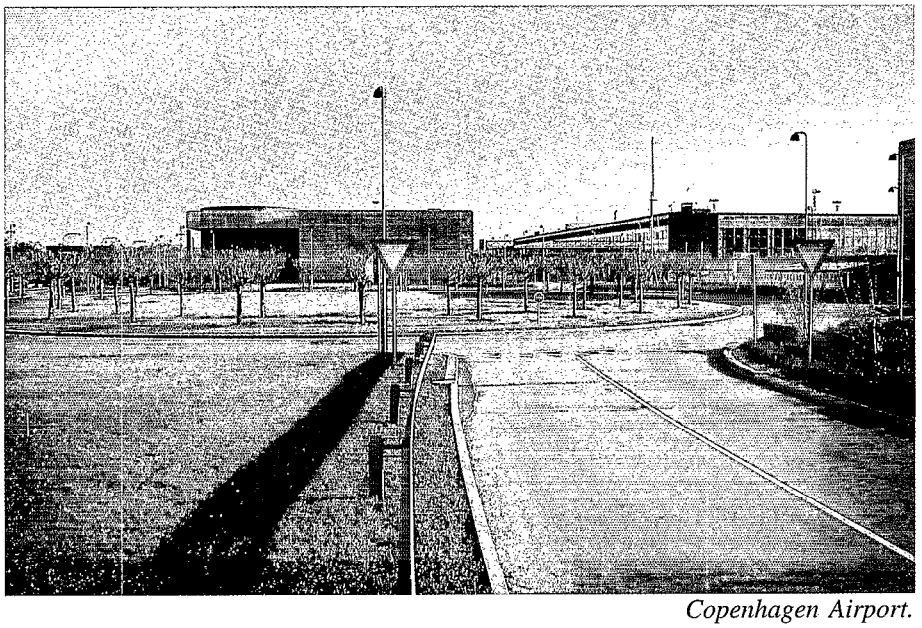
Tarm.

Tarm

In 1991 four gates were inaugurated in Tarm, in Egvad municipality in Ringkjøbing county.

The design of the gates differs a little, but they all include two steel towers linked by a girder. The text on the girder can be replaced, so that drivers can be given some brief information about current events in the town.

The gates cost about DKK 100,000 each.



Copenhagen Airport.

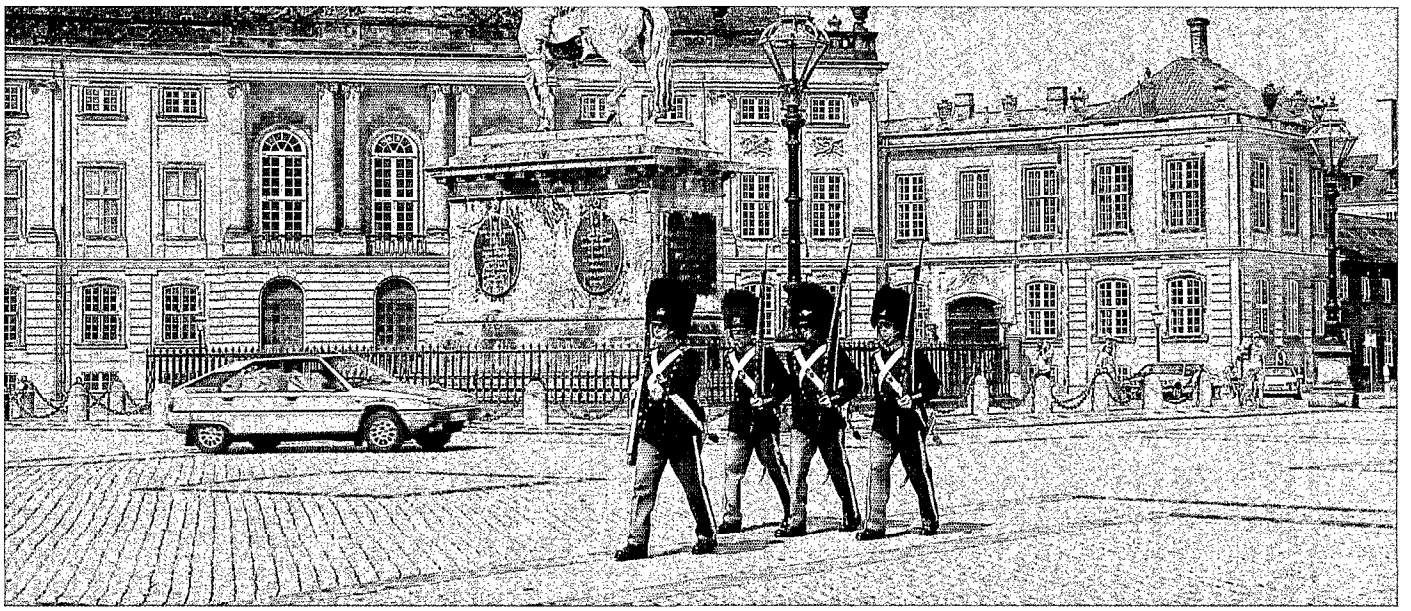
Copenhagen Airport

Also a roundabout can function as a kind of gate - to a town or to a special area.

In conjunction with a conversion of the access and parking conditions at the international flights terminal of Copenhagen Airport, a roundabout was established, in 1991, as a gate to the area.

The roundabout has an effective speed reducing influence on car traffic coming from the Copenhagen motorway, and at the same time it functions as a clearly understandable distributor ring for the traffic bound for the bus car parks, the taxi car parks, and the short- and long-term car parks respectively.

Roundabouts - a Theme



Through the 1960s and 70s a large number of roundabouts were abolished, mainly to provide an unhindered traffic flow for the growing car traffic. With the change of the right-of-way rules in 1976 the possibilities of accommodating the traffic were considerably improved, and in the following years there was a growing appreciation of the value of roundabouts in connection with speed reduction and the improvement of traffic safety. Especially very recently this has resulted in the establishment of a large number of roundabouts.

Fredensborg

For the silver wedding of the Danish royal couple in 1992 the avenue to Fredensborg Castle was converted, to a certain extent in accordance with a 200-year old project for the road. At the same time a roundabout was established where the avenue, which continues into a highway towards Hørsholm, intersects the highway between Hillerød and Helsingør.

The radius of the central island is 9 m. The width of the circulation area is 11 m, of which the 3.5 m closest to the island has a rumble surface. A 2 m wide cycle track has been established, separated from the circulation area by a 1 m wide dividing island.

On the central island a very characteristic octagonal cone has been erected in addition to limetrees and ivy, plus also "gas lamps" similar to those placed along the avenue to the castle.

To the traffic both from Hørsholm and from Hillerød the roundabout functions as a gate to Fredensborg.

Construction costs were DKK 3 m.

Solrød

On a 1.8 km long stretch of Gammel Køge Highway in Solrød in Roskilde county, five roundabouts were established in the period 1989/92. At the same time the highway has been converted

Fredensborg.

from a 4-lane road with cycle tracks and sidewalks on both sides to a road with only 1 lane in each direction, a central reservation, dividing islands on the sides with parking bays and bus laybys, plus cycle tracks, and sidewalks.

The central islands of the roundabouts have a radius of 6 m and the circulation area is 7.5 m wide. Immediately outside the circulation area there is a 2 m wide cycle lane.

Total construction costs are estimated to be DKK 19 m, of which each roundabout accounts for about DKK 2.4 m. The fairly high price is caused, among other things, by the fact that the conversion was made on an existing road with an annual traffic per day of 9,000 vehicles, and with many shops and accesses to buildings generally. Special costs were also imposed by the taking up of a reinforced concrete carriageway where the central reservation is now placed, and by the replacement of the entire road drainage system.

Mårum

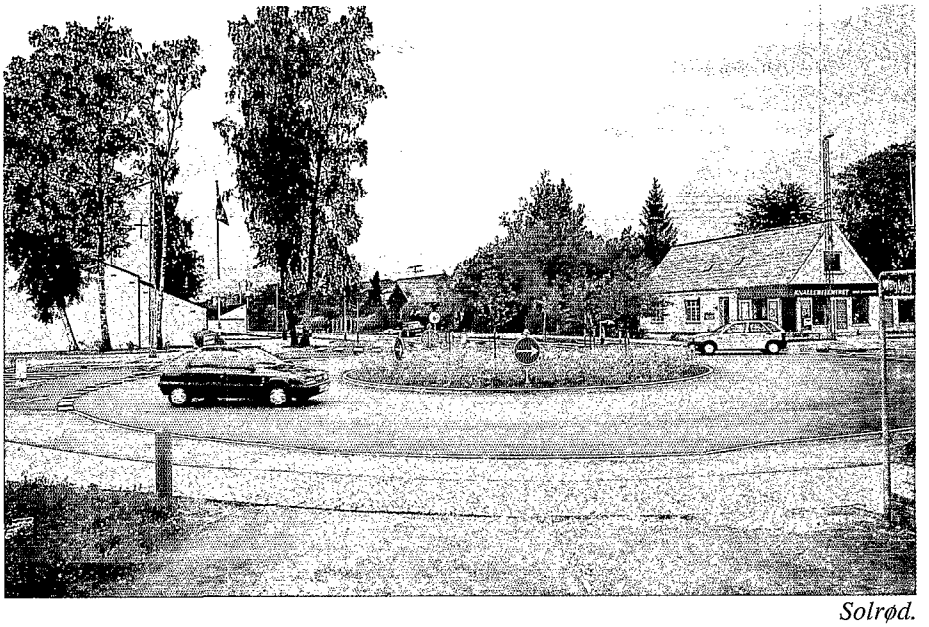
Where the highways Helsinge-Helsingør and Græsted-Kagerup intersect in Mårum in Frederiksborg county, a roundabout was established in 1988.

There are no cycle tracks in the access lanes, but a 2 m wide blue cycle lane was provided in the roundabout, marked by a 30 cm wide broken line. The radius of the central island is 7 m, and of the 8 m wide circulation area the 3 m closest to the island have been given a rough surface that lorries can cross.

Viborg

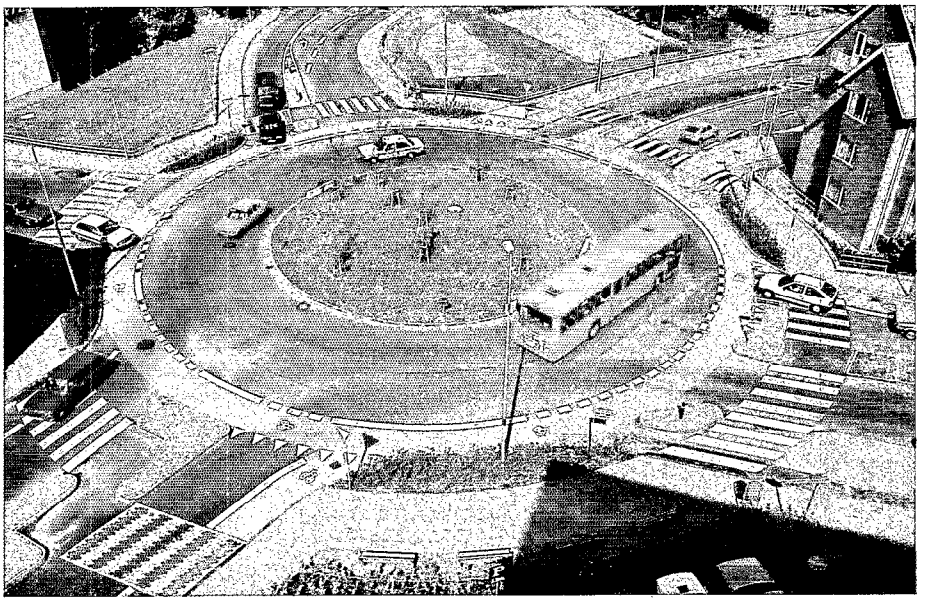
Since 1988 five roundabouts have been established in Viborg.

Two of them have been placed on arterial roads. They have been provided with high, planted central islands, so that the free sight through the roundabout has been obstructed, and with red cycle lanes marked by 30 cm white lines and cycle symbols.



Solrød.

Mårum.



Viborg, the roundabout on the central ring road.

In the roundabout on the central ring road humps have been established at all entries in the form of zebra crossings in black and white concrete paving stones.

Construction costs for the individual roundabouts varied from DKK 215,000 for the smallest to DKK 2.3 m for the largest.

All the roundabouts have had the desired effect. According to the municipality speeds have been reduced and the safety increased.

Odense

Already in 1939 a large roundabout was established in the 6-legged intersection Kochsgade/Døckerslundsvej/Bellisvej/Risingsvej in Odense. In 1990/91 the roundabout was thoroughly renovated at a cost of DKK 600,000.

The radius of the central island is 17 m and the width of the circulation area is 8 m plus a 2 m wide cycle lane.

Due to its age and the recent renovation the roundabout has a very modern geometrical design but is also characterised by its old plantings.

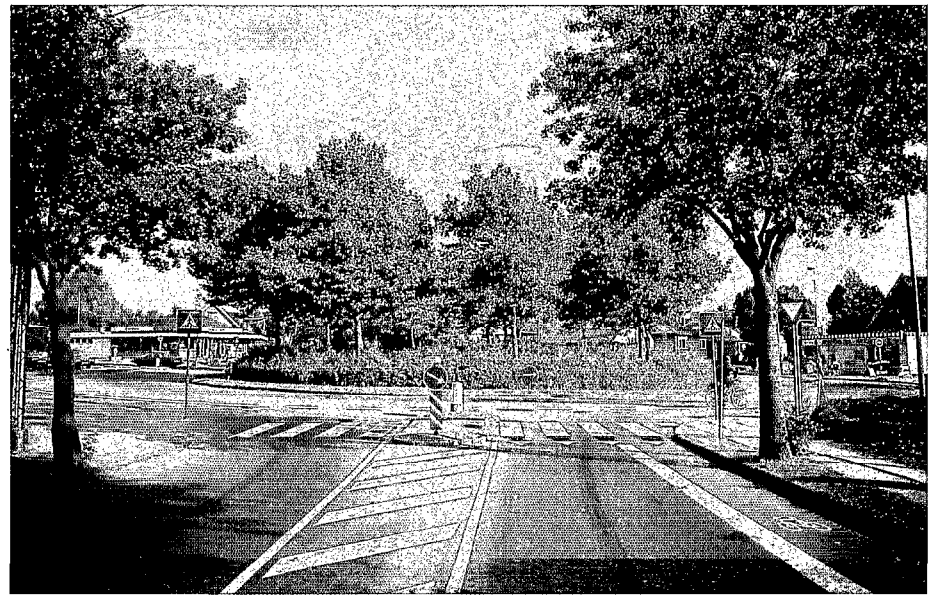
According to Odense municipality the annual traffic per day is about 14,000 vehicles, and before the conversion 7.3 accidents occurred every year.

Lyngby

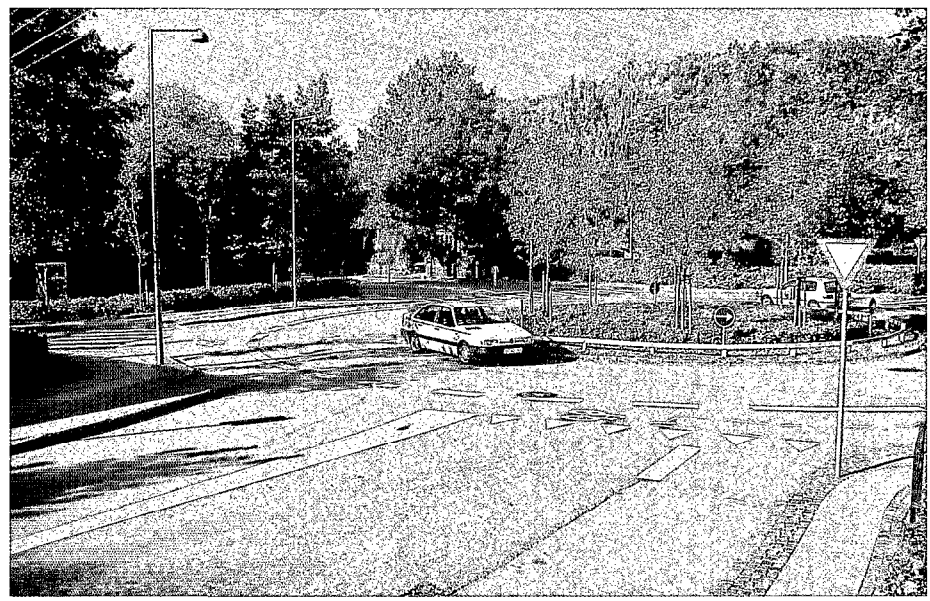
In the 5-legged intersection Nøjsomhedsvej/Ørholmvej/Kulsviervej/Egegårdsvej in Lyngby in the County of Copenhagen a roundabout was established in 1988.

The radius of the central island is 7.5 m and the width of the circulation area is 6.5 m, in addition to which there is a 2 m wide cycle lane, marked by white road marking. Trees have been planted on the central island.

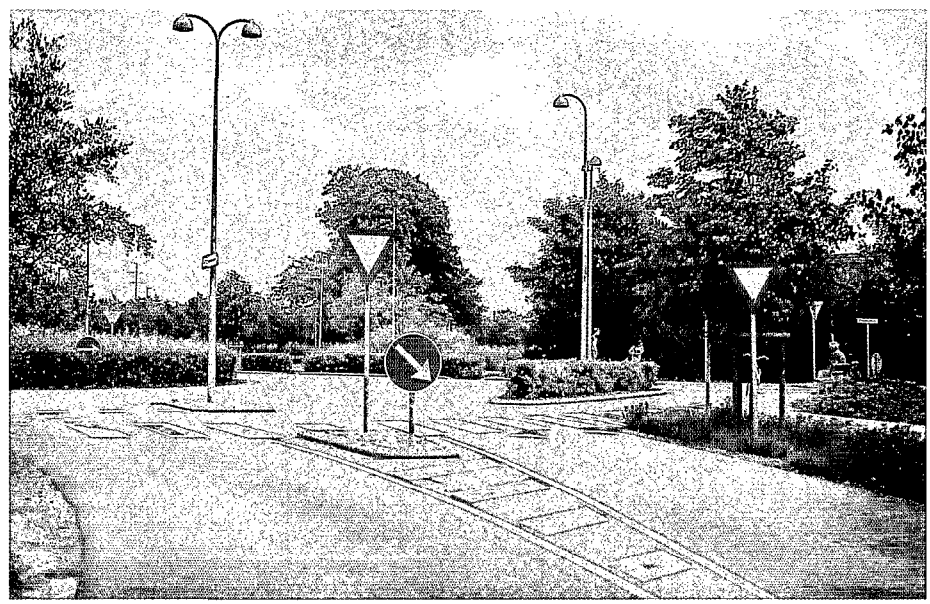
Construction costs were DKK 800,000. The purpose of the facility was to reduce speeds on Nøjsomhedsvej-Ør-



Odense.



Lyngby.



Billund.

holmvej, which has been achieved. According to Lyngby-Tårbæk municipality two accidents occurred over a two-year period before the conversion, whereas one accident has occurred in 3 years after the conversion.

Billund

As part of the Danish Road Directorate's "Local Safety Campaigns" programme two roundabouts were established in 1986 *(25)*.

The radius of the central island is 8 m and the width of the circulation area is 10 m, of which the 2 m closest to the island has a rough road surface. A 2 m wide cycle track has been established, separated from the circulation area by a 1.5 m wide deviding island.

On the central island of one of the roundabouts a 90-year old chestnut tree has been transplanted - which thrives well after being moved.

The individual roundabouts are constituent parts of a large scheme, and the price for the roundabouts cannot be extracted from the whole. However, the budget for a similar roundabout now under construction in Billund is DKK 1.7 m.

Allerød.

Allerød

In Allerød, in the intersection between Amtsvej, Allerødvej, Skovensvej and Frederiksborgvej, a mini-roundabout was established in 1989.

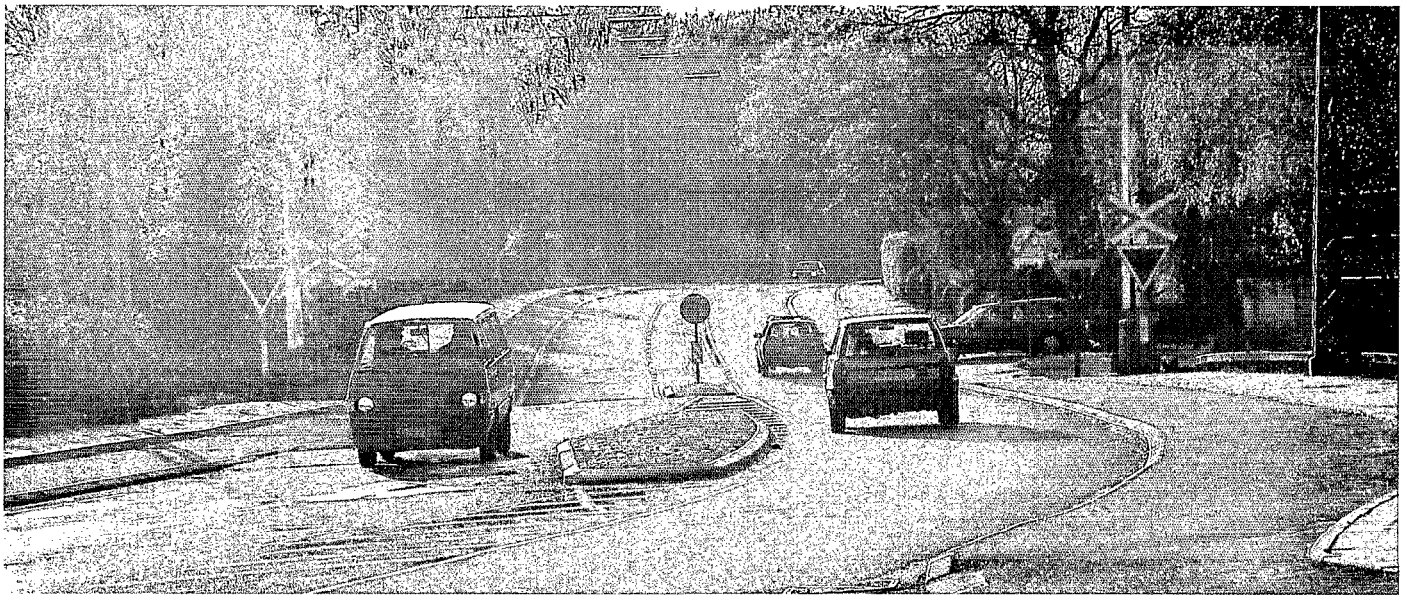
The junction from Skovensvej was designed as an exit construction, whereas the other junctions were designed with zebra crossings and small traffic islands.

The outer radius of the roundabout is 11.2 m, of which the outermost 1.6 m is a blue cycle area. The central island has a radius of 4 m and is paved with granite cobbles so that it can be crossed by vehicles. A distribution van, for example, can go through the roundabout in the normal fashion, whereas larger vehicles will have to cross the central island.

The conversion of the intersection cost DKK 260,000.

According to Allerød municipality the total traffic in the roundabout is about 5,100 cars and 500 bicycles per day. In the years 1983-88 ten accidents were recorded in the intersection, whereas none have been recorded since the conversion.

Humps - a Theme



Already the exit constructions which far-sighted municipalities started to place some 40-50 years ago at side-road junctions to more arterial roads were devised to bother the drivers a little, and so remind them to reduce speeds and watch out. This motive has been carried on in the humps which now, in their thousands, are part of Danish traffic calming schemes, probably as the single most important element - in recent years also on traffic roads.

Frederiksborg County

After an initial experiment in 1988 with two humps on the highway through Vinderød, Frederiksborg county in 1989-90 initiated other experiments involving humps on the highways through Vejby, Ramløse, Emdrup, and Ålsgårde. The annual traffic per day in the above mentioned towns ranged from 2,000 to 5,000 vehicles. The experiences were so positive that another ten projects were implemented in 1991-92 in Nygård, Tikøb, Mårum, Lynge, Græsted, Jægerspris, Ganløse, Nødebo, Hornbæk and Ålsgårde.

A number of the latest projects constitute part of larger overall schemes with humps established on several roads, often in co-operation with the municipalities in question, and often combined with the establishment of gates.

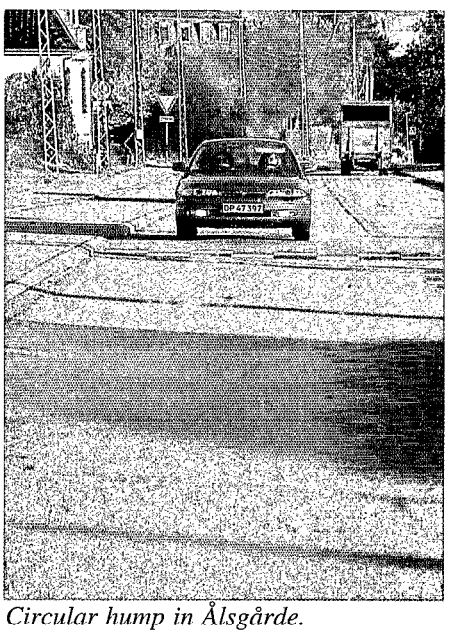
The number of humps varies from 2 to 8 per project. All the humps are circular humps with reference speeds of 40-50 km/h, in Jægerspris, however, 60 km/h.

The construction costs are DKK 15,000 per hump, to which should be added a similar sum for supplementary road lighting, changed road drainage, etc.

The county's experiences with the many projects are that

- the humps should be designed very carefully on the basis of the desired reference speed, and that they should also be supplemented by a strip of asphalt to smooth out the transition from the carriageway to the hump
- the humps should be separately illuminated
- the road marking should be clear, incorporating correct pre-warning and three rows of chess board marking at the beginning of the hump

According to measurements carried out by Frederiksborg county the establishment of the humps has reduced average speeds by between 5 and 18 km/h, and especially the very high speeds have been significantly lowered. The annual accident rate has been reduced by about two thirds.



Circular hump in Ålsgårde.

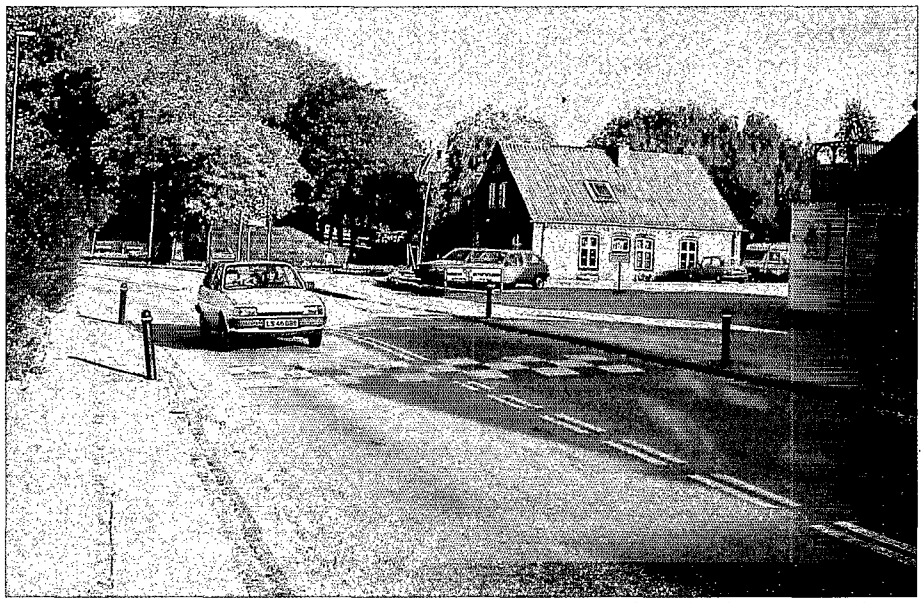
Ryslinge

In Ryslinge on Funen speeds were too high on the highway between Hårby and Ørbæk. The annual traffic per day was about 3,000 vehicles, and 13 accidents occurred in a 5-year period, which was three times as much as should be expected.

In 1990 five humps were therefore established on the highway and one on a crossing road. The project also comprised lighting, plantings, and a local speed campaign.

The humps were designed as circular humps suitable for 45 km/h, provided with normal chess board marking and indicated by bollards.

The price for the entire scheme was DKK 600,000 and according to measurements performed by the county of Funen, an average speed reduction was achieved from 57 to 49 km/h.



Circular hump in Ryslinge.

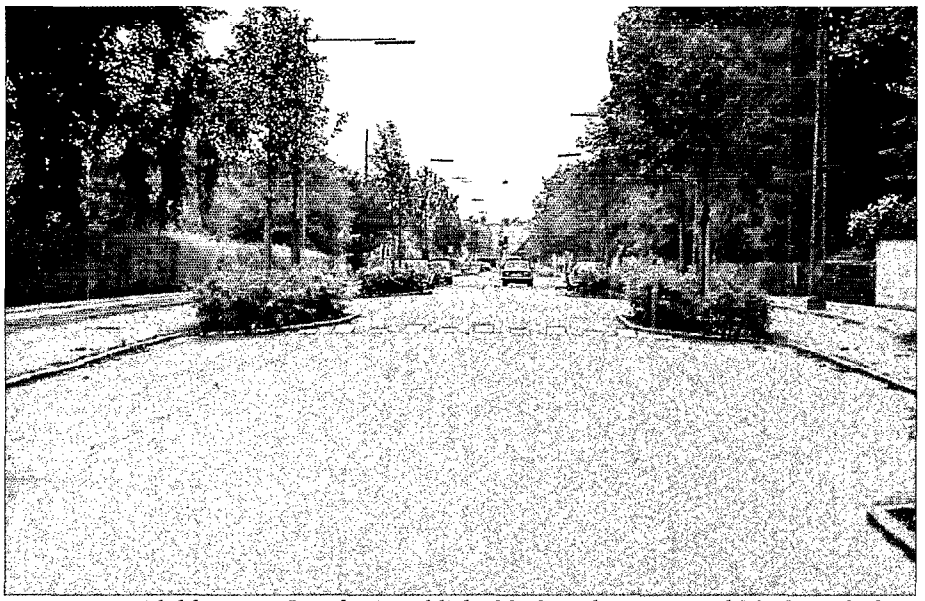
Hillerød

In Hillerød in Frederiksborg county there were plans, in the 1970s, to make a road without roadside buildings, parallel with the road towards Allerød. Later on planners settled for having traffic continue on the existing road, where speeds were much too high and consequently also the accident rate. The annual traffic per day was about 5,000 vehicles.

Circular hump in Hillerød.

In 1991 the municipality therefore established ten circular humps on the road, designed for 50 km/h, with chess board marking, and in some cases marked by bollards.

The humps cost DKK 14,300 each including road signs and road marking. The effects have not been measured.



Trapezoidal hump in Lyngby (established before the new Road Marking Order).

Lyngby

Christian X's Allé in Lyngby in Copenhagen County is a traffic road, but at the same time a school route. Therefore, in 1983/84, two humps were established on the road, spaced 60 m.

The humps were designed as trapezoidal humps across the whole width of the carriageway, but at the same time the carriageway was narrowed down, and parking bays were established on both sides, separated from each other by plantings.

The price for the entire conversion was DKK 120,000.

Snejbjerg

Tanderupvej in Snejbjerg in Herning municipality and Ringkjøbing county is an access road to Snejbjerg. Even though the road runs through an area with residential, detached houses and even though it lies on the town-side of the urban zone sign, car drivers tended to continue through at highway speeds. Consequently, in 1991 two humps were established on the road 230 m apart.

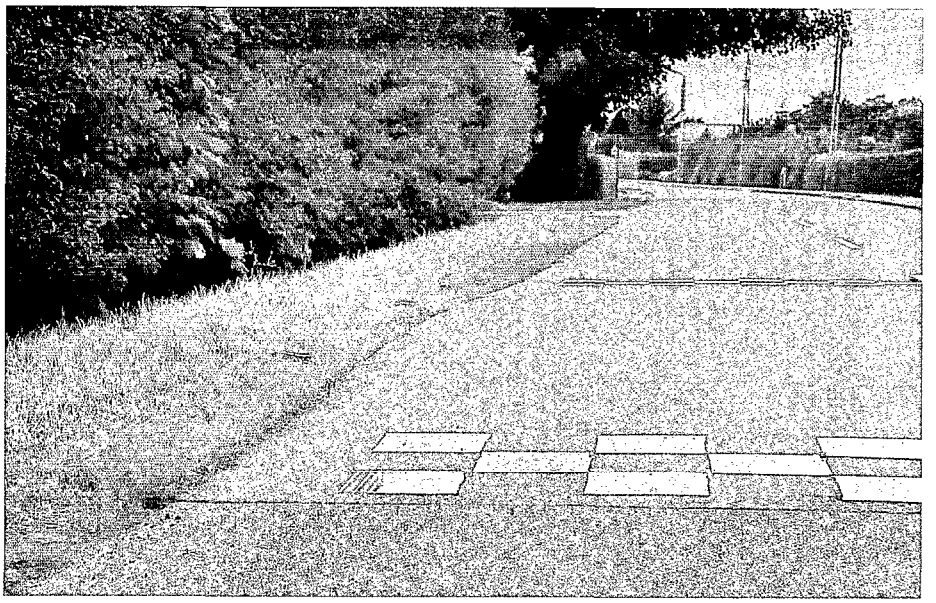
The humps were designed as sinusoidal humps across the whole width of the road, 9.5 m long and with a maximum height of 10 cm. The road marking are 90 cm wide chess board marking placed 1 m before and after the hump.

The price for each of the humps was about DKK 20,000. According to Herning municipality's observations the average speed for cars has been reduced from 50 to 44 km/h, whereas the speeds of buses and lorries are about 15 km/h lower. A bus route crosses one of the humps before turning away from the road, which does not seem to bother the driver, nor the passengers.

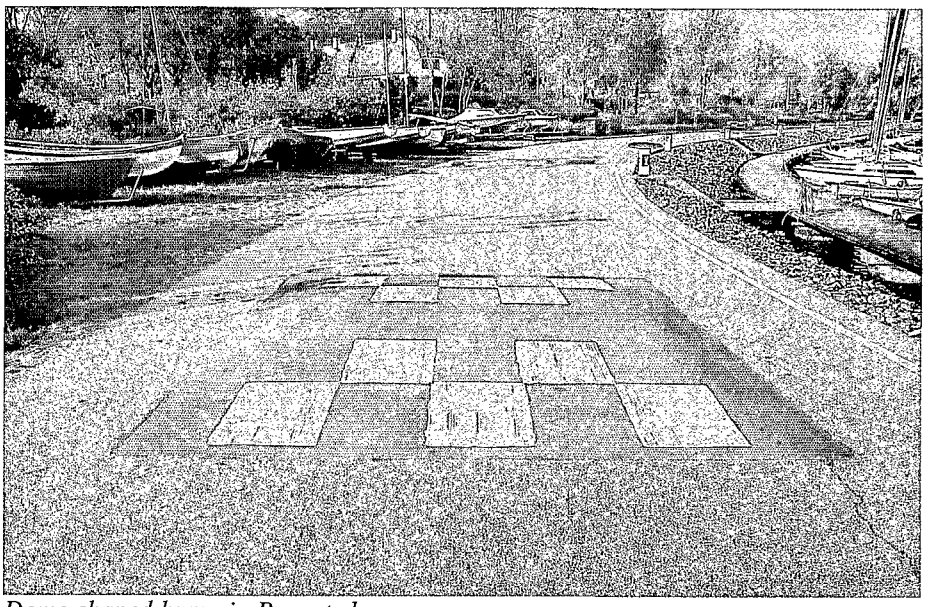
Rungsted

At Rungsted harbour, in Hørsholm municipality in Frederiksborg county, three humps have been established, in 1992, on the road leading to the southern jetty.

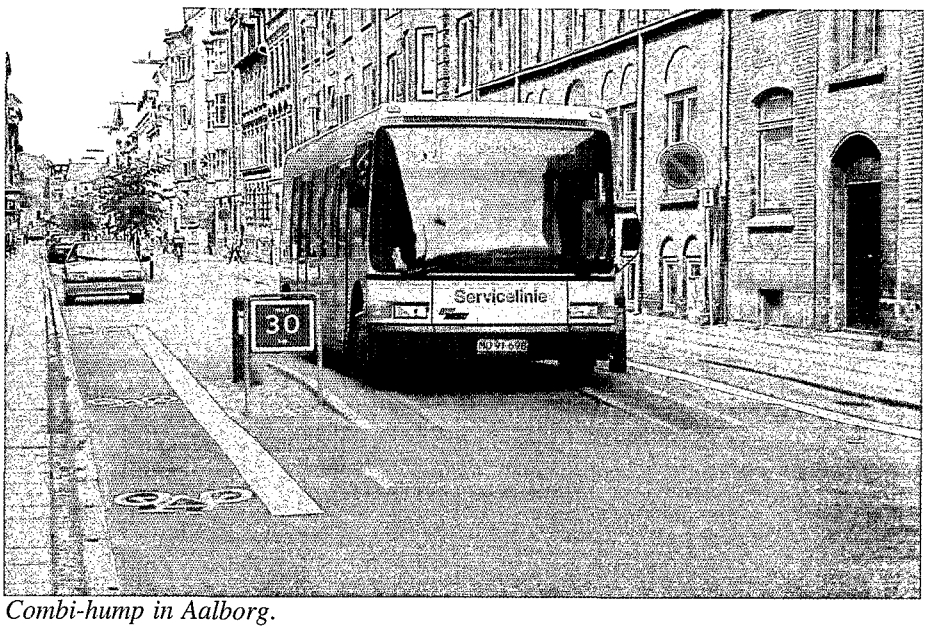
The humps are designed as dome-shaped humps, and the price was DKK 42,000 for the three humps.



Sinusoidal hump in Snejbjerg.



Dome-shaped hump in Rungsted.



Combi-hump in Aalborg.

Aalborg

Danmarksgade is situated in the centre of Aalborg. In order to make the city centre calmer it was decided to lead the traffic away from Danmarksgade and on to the surrounding arterial road system. So in 1988 two humps were established.

However, bus services used Danmarksgade and therefore the humps were designed as combi-humps, so that cars had to pass a cobbled and fairly steep hump, whereas there were two less steep asphalt humps designed for the track gauge of the buses.

The humps were marked by 30 km/h road signs and were indicated by bollards as well.

Construction costs were DKK 75,000 per hump.

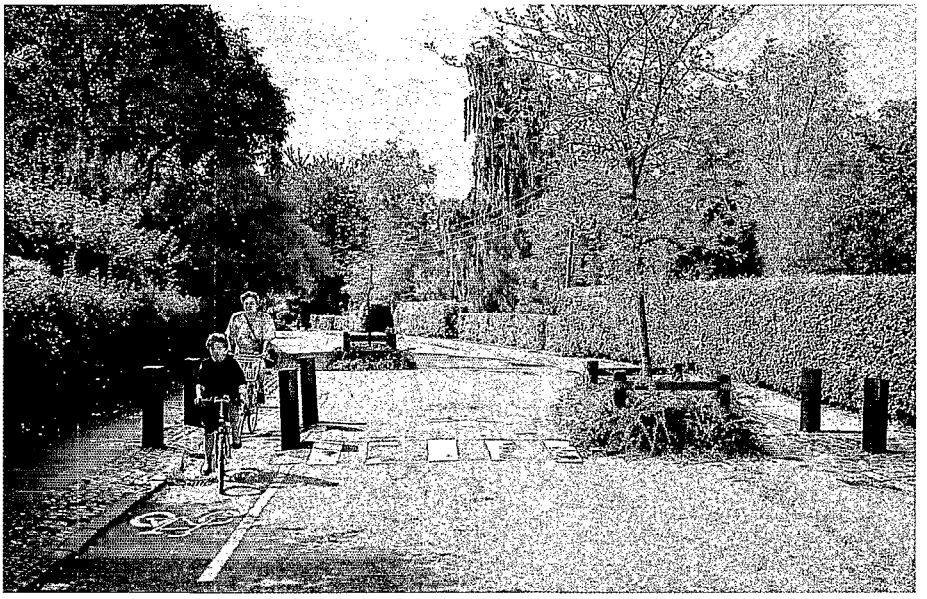
Most drivers chose to drive with one wheel on one of the asphalt lanes, but this did not change the speed reducing effect. A number of measurements performed in conjunction with the preparation of "Byernes trafikarealer" *(16)* showed that cars cross the hump at an average speed of 25 km/h whereas the mean speed of the heavy vehicles was 20 km/h. The 85% quantile was 30 and 25 km/h respectively.

Søborg

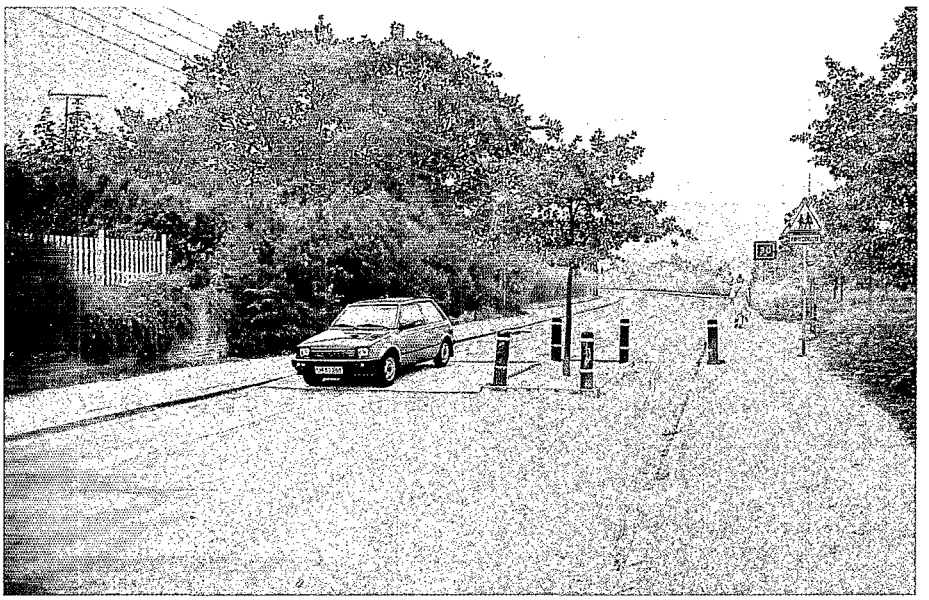
In 1981, on Kong Hans Allé in Søborg, in Gladsaxe municipality in Copenhagen County, six humps were established 50-100 m apart.

Across the humps the carriageway has been narrowed down to one lane by means of 1 m wide reservations with trees, and there are 1.3 m wide cycle passages between the reservations and the sidewalks. The humps are designed as trapezoidal humps, 8 m long including two 1 m wide ramps, and paved with cobbles. There are also trapezoidal humps in the cycle passages, but these are paved with asphalt and the ramps are 2 m long.

Cobbled, trapezoidal hump in Søborg (established before the new Road Marking Order).



Trapezoidal hump in Birkerød (established before the new Road Marking Order).



Circular hump in Espergærde (established before the new Road Marking Order).

In connection with the preparation of "Byernes trafikarealer" *(16)* the average speed has been measured to be 21 km/h on the humps and 38 km/h between the humps.

Birkerød

Kajerødvej in Birkerød, in Frederiksborg county, was one of the very first silent roads in the country. In order to declassify the road to a local road six staggerings with narrowings were established, in 1980, on the 500 m long section, with trapezoidal humps in the first and the last staggering *(62)*.

This reduced the average speed on the stretch to 36 km/h, but as some drivers were still driving too fast, trapezoidal humps were provided, some years later, in the remaining four staggerings as well.

The cyclists are led past the speed reducers via cycle passages.

No accidents have been recorded on the section neither before, nor after the conversion.

Espergærde

In Espergærde, in Helsingør municipality in Frederiksborg county, Nørremarken is part of the traffic network, among other things as a connection from the Helsingør motorway to the town centre. At the same time the road is the main access road to a primary school, and has no cycle tracks. In 1985, following appeals from the school board and a sign-in campaign among parents and inhabitants the municipality established three humps spaced about 80 m on the stretch between the school and the local youth centre.

The humps are designed as circular humps for passage at 30 km/h, and the carriageway has been narrowed to one lane across the humps by means of an island with a tree, marked by bollards. To emphasize the humps they have been paved with light concrete flag stones. In one direction the cyclists have to cross the humps, whereas in the other they are taken outside and around the speed reducer via a cycle passage.

Construction costs amounted to about DKK 50,000 per hump in 1985, including road drainage, plantings, and signs.

Road signs specify a recommended maximum speed of 30 km/h and in connection with the preparation of "Byernes trafikarealer" *(16)* the average speed was measured to be 26 km/h on the humps and 37 km/h between the humps.

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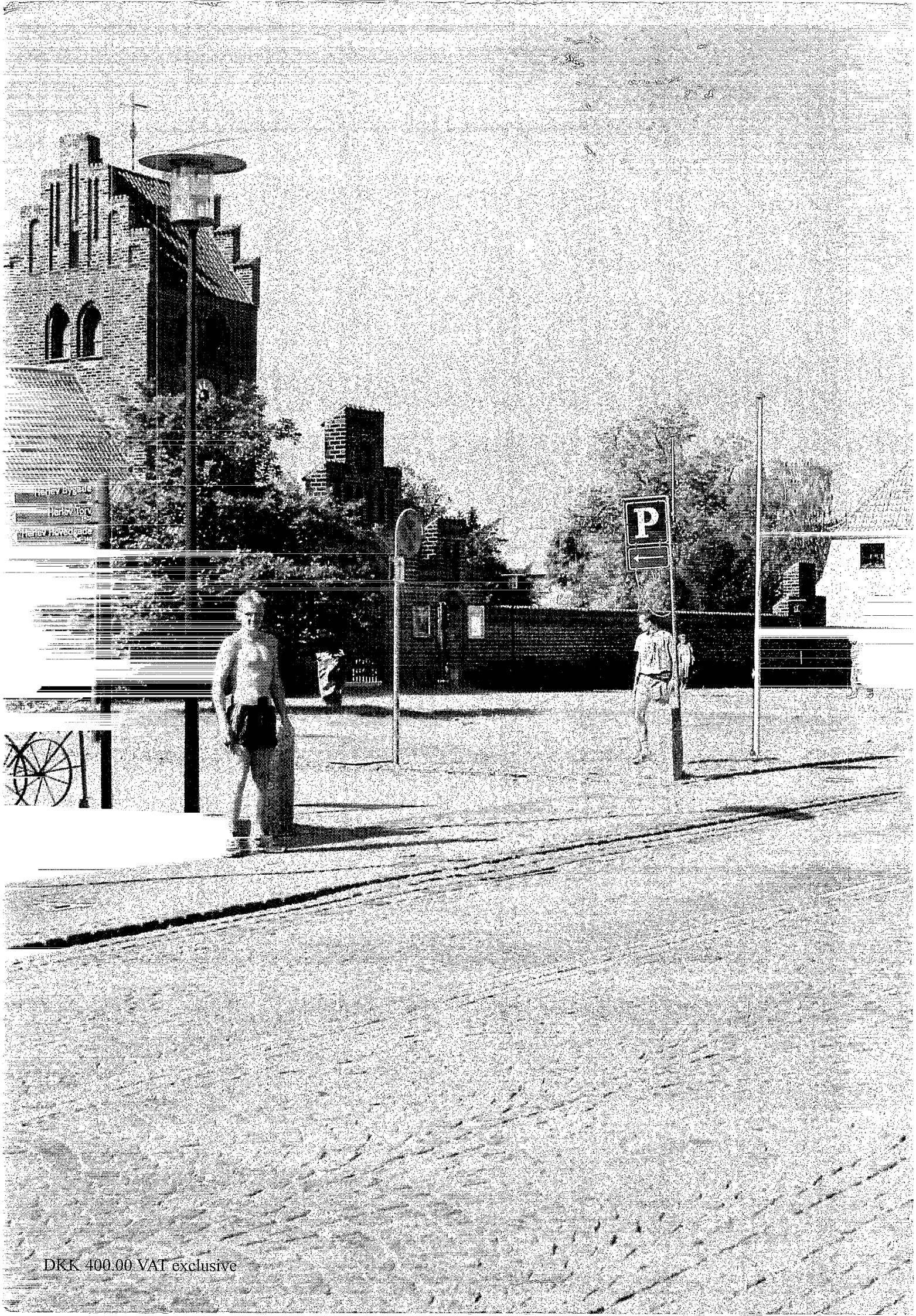

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